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COMMERCIAL FISHERIES Review

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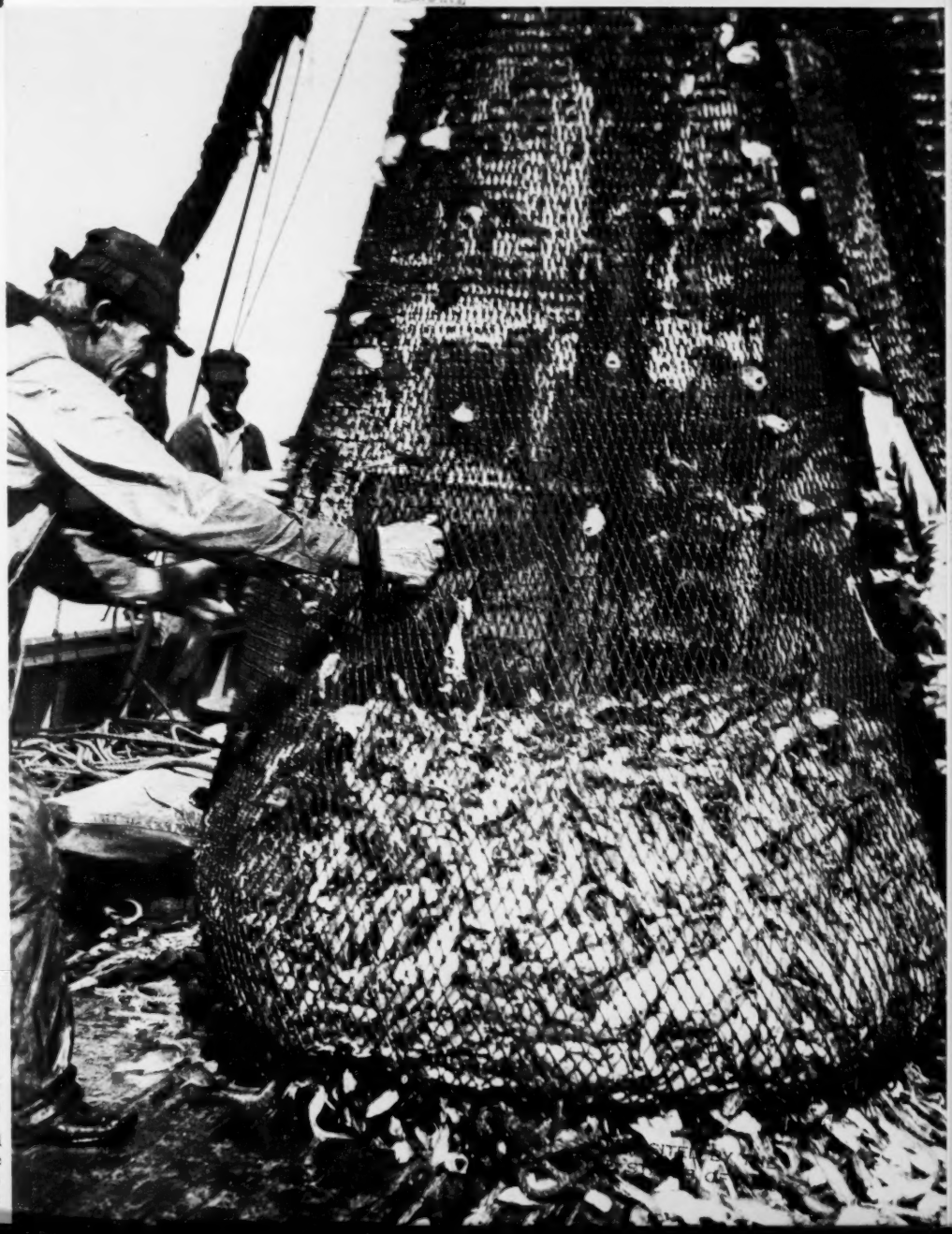

U.S.
DEPARTMENT
OF
COMMERCE
National
Oceanic and
Atmospheric
Administration

National
Marine
Fisheries
Service

U.S. DEPARTMENT OF COMMERCE
Maurice H. Stans, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Dr. Robert M. White, Administrator
Howard W. Pollock, Deputy Administrator
Dr. John W. Townsend Jr., Associate Administrator

NATIONAL MARINE FISHERIES SERVICE
Philip M. Roedel, Director

COVER: Shrimp catch in Gulf of Mexico off New Orleans.

COMMERCIAL FISHERIES

Review

A comprehensive view of United States and foreign fishing industries--including catch, processing, marketing, research, and legislation--prepared by the National Marine Fisheries Service (formerly Bureau of Commercial Fisheries).

FISHERMEN'S MEMORIAL--GLOUCESTER, MASS.

Editor: Edward Edelsberg

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Throughout this book, the initials NMFS stand for the NATIONAL MARINE FISHERIES SERVICE, part of NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION (NOAA), U.S. Department of Commerce.

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CONTENTS

	Page
UNITED STATES	
Events and Trends	1
ARTICLES	
Distribution of Some Coastal Pelagic Fishes In The Western Atlantic, by Edward F. Klima	21
The Atlantic Surf Clam Fishery - 1969, by Allan M. Barker and John W. Ropes	35
Trapping Sablefish, by William L. High	43
Coho Shaker Problem & Incidental Catch Concept In Troll Fishery, by Sam Wright	48
BOOKS	51
INDEX	56

An Alaska fur seal family on St. Paul Island, Pribilof Group, Alaska. (Photo: V.B. Scheffer)

SEC. STANS REPORTS FAVORABLY ON SEAL HARVESTING IN PRIBILOF ISLANDS

Secretary of Commerce Maurice H. Stans reported, July 14, 1971, his conclusions on methods used to harvest seals after a visit to the Pribilof Islands off Alaska in the Bering Sea on July 8 and 9.

He went to observe fur-seal management, conservation practices, and to review harvesting methods because of recent criticisms.

He consulted with 6 veterinarians named by the American Veterinary Medical Association to study the harvest methods; the administration of St. Paul, the major Aleut community in Alaska, located on one Pribilof island; representatives of the American Humane Association, the International Society for the Protection of Animals, and the Humane Society of the United States, who were observing the harvesting; officials responsible for Canada's seal harvesting; the National Marine Fisheries Service, responsible for harvesting and preparing the seal skins.

The Secretary said: "The issue is not whether we will or will not continue to manage the fur seal herd. The issue is how we will manage the seal herds at their optimum levels most humanely."

The Secretary said present management practices were reached after the near extinction of the herd 60 years ago. If the internationally negotiated management program were stopped now, it would very likely result in the same catastrophic effects. These could include resumption of high-seas hunting with indiscriminate slaughter, and a very high mortality rate of the pups on shore.

STANS' CONCLUSIONS

"As a result of my meetings and my personal review of the situation," he said, "I can report the following conclusions:

"1. There is no molestation or harvesting of the female seals, the pups or the male bulls associated with the harems in the rookeries. The only harvesting that takes place is of male seals three or four years old who situate themselves at a distance from the breeding herds.

"2. Except for the fact that the operation takes place in the open, the method of harvesting is very similar to that which takes place in a meat-packing plant. The herd of male seals is removed about 100 yards from the beach, sorted into groups of from six to ten, and each animal in a group is then rendered unconscious by a quick blow to the head and immediately killed by bleeding. The entire process, including the skinning of the dead animal, takes about one minute.

"3. Investigations have been conducted over a period of years to determine whether or not there is a more efficient method of harvesting. None has been found. The six veterinarians on the spot have been asked by me to make any recommendations for a more humane method of harvesting, and their report will be made to me upon the completion of the assignment. If their scientific studies establish that a better method is practicable, it will be adopted.

"4. The annual period of harvesting and the number of seals harvested is determined carefully on a basis that will maintain the

population of the seal herd at its optimum level. As a result of this process, the number of seals on the Pribilofs is currently estimated at 1,300,000, compared to only 200,000 in 1911. There is no present danger whatsoever of extermination of the herd under these policies.

"5. The harvesting of the seals is the source of practically all of the income of the 700 Aleut residents of the Pribilof Islands. To deprive them of this income would make them dependent on the government. The local officials make it quite clear that they want the harvesting to continue so that the residents can earn a living and that under no circumstances do they want to move from the Islands.

"6. Any implications, such as those recently published, to the effect that baby seals are harvested, that harvesting is depleting the herd, that harvesting methods are inefficient or inhumane, or indiscriminate, are totally unfounded. The crop of these animals is being managed and harvested under scientific practices just as domestic animals are raised and harvested.

"Ending the program would not be in the interest of a sustained seal population, the Aleut workers, or the federal government. I repeat, if and when more humane methods of harvesting are found and satisfactorily tested, they will be adopted."

Secretary Stans noted the fur-seal management program is one of the most effective wildlife conservation and management programs in history.

NMFS STUDIES HEAVY-METAL CONTAMINATION OF FISH

NMFS scientists are working to define the nature and extent of heavy-metal contamination in fish found in coastal and offshore waters. The program involves 6 NMFS laboratories and the cooperation of other Federal agencies and the fishing industry.

The scientists are concerned over the decline in sales in New England of tuna and lobster. During the recent mercury scare, the two were withdrawn from the market for testing by Federal and state governments.

Fish eaters in New England have received strong assurances that they can buy with safety any fish item--swordfish excepted--from the shelves or in restaurants.

Swordfish was not included because the U.S. Food and Drug Administration (FDA), citing the too-high mercury content, warned the public not to eat it.

The NMFS research program has 3 phases:

1. In April, research vessels began gathering offshore species. Inshore gathering of shellfish and fish already was underway. Specialists will be trained for analytical work, highly specialized equipment set up for testing heavy metals, and fish samples submitted by commercial and sport fishermen cooperating with NMFS.

2. As many marine and freshwater fish as possible are being surveyed and tested in the laboratory. In 1969, the FDA set a maximum permissible limit of 0.5 ppm in food in a daily diet. Most scientists believe this criterion provides a considerable safety margin.

Another aim of the testing is to pinpoint the body parts that store and carry the contaminants. Questions that have to be answered include: Are metals isolated, or evenly distributed in all body parts? What is the significance of flesh color? Are size and weight of fish important factors? How do heavy-metal levels in the whole fish relate to product consumed? To answer this last question, 30 fishery products will be analyzed--such as fish sticks, fish portions, fish cakes, and fish for frozen dinners. Earlier this year, frozen fish blocks (compressed fish) were tested with very favorable results. The blocks are made from the edible portion of cod, haddock, flatfish, and pollock that run the North Atlantic waters. The U.S. consumes annually 270 million pounds, 98% imported from about 50 countries and processed in Massachusetts, Maine, and New Hampshire.

3. This phase is more complex. Existing garbage-dumping stations were selected along the coast from Connecticut, Long Island, south to Delaware. Fish and shellfish taken shoreward from these ocean dumps--and those near the dumping areas are being tested in relation to current flows, water samples, natural and unnatural environmental living conditions of the fish, levels of comparative change, physiology, and mortality rates.

All NMFS lab test results are being sent to FDA.

Much fishing industry money that once went for market promotion now goes for research. A voluntary inspection program, a sampling

of the finished fish product, is financed by the industry, mostly processors and shrimp manufacturers. Inspection stamps provide a reasonable degree of assurance to the consumer. Private firms are running spot checks, rechecking, and then monitoring regularly.

The traditional FDA market-basket survey now includes fishery products. NMFS says this is "just another step to protect the consumer."

This is still a crisis period, NMFS scientists caution. The swordfish industry has been virtually destroyed; the industry was made eligible in May for "product disaster assistance" from the Small Business Administration in the form of low-interest loans.

Tuna has fared much better. Only a few lots have been condemned. "There is no health hazard involved in eating tuna now held on retail shelves or in the household," NMFS scientists emphasize.

MERCURY

Mercury, a metallic element known too as quicksilver, is the only heavy metal that remains liquid at ordinary temperatures. Since the start of the Industrial Revolution, it has been used in everything from barometers to pesticides and fungicides. It is found in three forms: metallic mercury; inorganic mercury (mercury chlorides, sulphides and nitrates); and the organic mercury compounds (phenyl mercury acetates, phenyl mercury nitrates, methyl mercury and ethyl mercury). The last are the most toxic form.

In the biological chain, the two first forms convert into the methyl or ethyl mercury compounds, which are also very soluble. Normally, the effects of significant contamination by most mercury compounds are reversible, short lived, and excreted from the body over a period of time.

With methyl-ethyl mercury compounds, however, effects are not reversible. If the ingestion level is high, there can be irreversible damage to the brain and, possibly, death.

Mercury occurs in nature--in the sea, soil, and all natural foods. It has always been there. The important thing now is to try to lessen and prevent increased pollution of the environment.

Dr. Fred Stare, Chairman, Department of Nutrition, Harvard Medical School, has said: "There really are no safe or unsafe substances, only safe or unsafe levels, and safe and unsafe ways of using any substance. This requires a certain amount of common sense as well as scientific sense and the two are not always the same."

[Information for parts of this NMFS story is based on an interview with Dr. J. Perry Lane, supervisory research food technologist, NMFS Technology Laboratory in Gloucester, Mass., conducted by Wanda Howard, assistant editor, monthly publication of New England Marine Resources Program.]

NMFS PROTECTS MORE 'CONTINENTAL SHELF CREATURES'

The National Marine Fisheries Service (NMFS) acted in June to prohibit foreign vessels from taking 10 more species of marine animals it classified "creatures of the Continental Shelf." An amended regulation became effective when published in the 'Federal Register' on June 23.

These creatures are defined in the 1958 Geneva Convention on the Continental Shelf; at the harvestable stage, they "are immobile or are unable to move except in constant physical contact with the seabed or subsoil of the Continental Shelf." The U.S. is party to the Convention.

This Convention is implemented by a 1964 U.S. law, the "Bartlett Act". Under it the U.S. can reserve to its own nationals the right to harvest certain marine resources determined to be creatures of its Continental Shelf--except if an international agreement provides otherwise.

Additions to List

The animals added in June include: precious red corals and black coral; surf clams and ocean quahog; and these crustacea: Dungeness crab, deep-sea red crab, northern stone crab, golden king crab, and two species of California king crab (Paralithodes rathbune and Paralithodes californiensis).

Species previously listed included: tanner, king, and stone crabs; red and pink abalone; Japanese abalone; queen conch; and 4 kinds of sponges.

NMFS Director Philip M. Roedel said the list can be modified from time to time.

Dungeness Crab
(Cancer magister)

U.S.-SOVIET FISHERY SURVEY CONTINUES OFF U.S. WEST COAST

The 'Ogon,' of the Soviet Far Eastern Seas Fisheries Research Institute (TINRO), out of Vladivostok, docked in San Pedro, Calif., on June 30 to meet U.S. scientists and plan a 5-month series of cooperative survey cruises off the U.S. West Coast. This was disclosed June 23 in a joint announcement by Dr. D.L. Alverson, NMFS Biological Laboratory, Seattle, Wash., and Dr. A.R. Longhurst, Director, NMFS Fishery-Oceanography Center, La Jolla, Calif.

Moscow Meeting Nov. 1970

At a Moscow meeting in November 1970, attended by Drs. Alverson, Longhurst, and other U.S. fishery scientists, it was agreed: 1) Ogon would conduct a hydroacoustic survey and do biological sampling of Pacific hake population between 37° N and 50° N latitude; 2) also, a biological research program on ocean perch and feeding habit studies of hake and other fishes.

The Ogon displays a large sign, "NAUKA TINRO SSSR" (Science-TINRO-U.S.S.R.), to help identify her research status.

Interest in Hake Estimates

The NMFS laboratories in Seattle and La Jolla are interested particularly in estimates of hake abundance the Soviets will make using a hydroacoustic survey method, and in a plan to put U.S. scientists aboard vessel in July and August. The Soviets have agreed in principle that on all cruises designated for cooperative U.S.-USSR research, they would accommodate U.S. scientists.

The Ogon has worked off West Coast for the past two summers. It is part of a continuing research program on fish species of common interest. The program includes periodic meetings to exchange data and to review and plan research. In recent years, the Soviets fished hake heavily. Information is necessary to provide both nations with scientific bases for agreements to protect this resource.

The Ogon is captained by Alexander Bolshakov. It is a 190-foot, blue-gray, side trawler carrying 42 persons. It will work off west coast until November, then be replaced by a larger Soviet vessel.

NMFS WOODS HOLE AQUARIUM BEGINS SECOND DECADE

On June 12, the NMFS aquarium at its Woods Hole (Mass.) Biological Laboratory began its second decade of public service. During the first decade, $2\frac{1}{2}$ million persons saw the fish and educational exhibits.

The aquarium is open year round. It is visited by student groups of all levels: from headstart and preschool to college and post-graduate scholars. More than 40,000 youngsters have come in these groups, mostly in spring and fall. Some students have been helped with science projects and thesis requirements.

Cooperation With Scientists

The aquarium also serves marine scientists and aquarists. Many times, it has provided living material and tank space for experiments in physiology, animal behavior, and other fields. Aquarium staff has kept daily records of seawater and air temperatures for nearly 10 years. These helped investigators.

A water-quality monitoring project to begin soon will increase the aquarium's value to the NMFS Woods Hole lab and the scientific community.

NMFS MIAMI LAB RELEASES MORE DRIFT BOTTLES

Contributions by the Miller Brewing Co. of 40,000 bottles in the past 4 years to NMFS Tropical Atlantic Biological Laboratory (TABL, Miami) have helped oceanographers study the currents in the Caribbean and Gulf of Mexico.

During July and August 1971, oceanographers again will "pepper" the Gulf and Caribbean area with thousands of bottles from 8 U.S. and Mexican research vessels participating in the "Cooperative Investigations of the Caribbean and Adjacent Regions."

Bottled Information

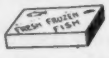
The bottles are ballasted with sand and contain a fluorescent orange card imprinted with a number and instructions in 4 languages. People who find the bottles washed up on beaches return them to TABL with information on time and locality of recovery. Returns have been received from nearly every country bordering the Caribbean, and from every state bordering the Gulf of Mexico and the U.S. South Atlantic coast. The oceanographers calculate the speeds and routes of currents from these widely scattered returns.

U.S. FISHERY PRODUCTS TO BE EXHIBITED AT COLOGNE FOOD FAIR

U.S. fishery products will be promoted at the world's largest food show in Cologne, Germany, Sept. 24-Oct. 1, 1971. The exhibition, attended primarily by food trade, is held every 2 years. U.S. fishery products have been promoted successfully since 1965.

In 1969, 46 nations sponsored exhibits. There were commercial exhibitions from 16 more countries. A total of 1,876 European exhibitors participated.

Germany is thriving and is an excellent market for U.S. foods. Consumption of frozen and convenience foods is growing rapidly as more housewives take jobs.



GULF & CARIBBEAN FISHERIES INST. MEETS NOV. 14-18 IN MIAMI

The annual meeting of the Gulf and Caribbean Fisheries Institute will be held at the Sheraton Four Ambassadors, 801 Bayshore Drive, Miami, Florida, Nov. 14-18, 1971.

Two sessions will be devoted to topics of specific interest to the fishing industry. Two sessions will emphasize current research in fisheries of Gulf of Mexico and Caribbean.

The International Game Fish Conference will hold its annual meeting Nov. 19 and 20.

For more information: Executive Secretary, Gulf & Caribbean Fisheries Institute, 10 Rickenbacker Causeway, Miami, Florida 33149.

COMMERCE DEPARTMENT BEGINS NEW STORM INFORMATION SERVICE

The Commerce Department's National Weather Service and National Bureau of Standards have established a new storm information service for deep-water sailors in the Atlantic and the Pacific. The service for the Atlantic is functioning; the Pacific operation is scheduled to begin August 1.

The new service consists of hourly broadcasts, up to 42 seconds each, providing information about major storms that might mean trouble for ships. The weather broadcasts are superimposed on Bureau of Standards time signals carried by stations WWV and WWVH.

Round the Clock

The broadcasts will be round the clock. Station WWV will carry information about storms in the western North Atlantic, 16 minutes after every hour, on radio frequencies 2.5, 5, 10, 15, 20 and 25 MegaHertz.

WWVH will list storms in the eastern and central North Pacific, 49 minutes after every hour, on 2.5, 5, 10, 15 and 20 MHz. The ocean areas covered are those for which the U.S. has warning responsibility under international agreements.

If there are no storm warnings in these areas, the broadcasts will indicate that. The brief messages will tell mariners if there are storm threats in their areas; they will not provide complete information. Mariners are expected to check with one of the regular marine broadcasts for details.

What Broadcast Covers

This is a hypothetical broadcast showing type of information mariners can expect to receive in the new service:

NORTH ATLANTIC WEATHER, WEST OF 35 DEGREES WEST, 1500 GMT. . .HURRICANE DONNA, INTENSIFYING, 24 NORTH, 60 WEST. . .MOVING NORTHWEST, 20 KNOTS. . .WINDS 75 KNOTS. . .TROPICAL STORM EVE, 17 NORTH, 50 WEST. . .MOVING EAST, 10 KNOTS. . . WINDS 50 KNOTS. . .STORM, 65 NORTH, 35 WEST. . .MOVING EAST, 10 KNOTS. . . WINDS 50 KNOTS. . . .SEAS, 15 FEET.

(Photo: Robert K. Brigham)

FISHERY PRODUCTS SITUATION

Donald R. Whitaker
NMFS Current Economic Analysis Division

The market for fishery products in the United States has maintained strength during the first half of 1971. Sales of some major species are slightly below year-earlier figures but, in the first half of 1971, this has been attributable primarily to shorter supplies. Conditions indicate a "seller's" market in most sectors. Prices have advanced sharply in face of tighter supplies of both shellfish and finfish.

Supplies of most shellfish are running below a year ago. Imports, as well as domestic landings, are down; declines in imports of shrimp have particularly affected the market. To meet market requirements in face of a drop in imports and domestic production, inventories of frozen shellfish have dropped sharply since the first of the year. Thus, the availability of stored supplies has made it possible for shellfish consumption to hold at nearly the same level as a year ago.

Groundfish Industry

Supply shortages have similarly affected the groundfish industry this year. The U.S. market for groundfish products is 83 percent supplied by imports. Imports are off from a year ago but, unlike shellfish, the groundfish industry did not have relatively large inventories on hand at the start of 1971. Thus, prices have advanced significantly, and groundfish sales are down from a year ago.

The shortage has had a particularly heavy impact on the fortunes of the "fish and chips" restaurant chains. The fast growth in the number of fish and chips outlets in the United States--from 500 or so in early 1969 to about 1,100 in early 1971--resulted in an unprecedented increase in demand for cod fillets. With supply shortages, prices began to skyrocket and adjustments in menu prices and portion sizes became necessary. The combination of short supplies and high prices may have temporarily halted the growth in fish and chips outlets. (See Canadian report page 9.)

Other Products

Halibut sales in the first half of 1971 have been consistent with last year. Prices changed little. Halibut production likely will be lower this year. Upward pressure on prices may build because of relatively lower supplies.

Canned salmon movements have been on a par with 1970. The 1971 pack will likely be below last year. So prices will gradually move up.

Frozen salmon sales have improved over a year ago, and prices have been firm. Inventories have dropped sharply since the first of the year but are still above normal.

Canned tuna movement has picked up considerably since the early months of 1971. Prices are expected to average higher than a year ago.

On balance, a slight decline in per-capita fish consumption in expected in 1971 after 3 consecutive years of increase. The major factors behind the decline will be higher prices accompanied by shorter supplies.

THE U.S. FOOD MARKET

How Trends Affect Outlook for Canadian Groundfish Products

There are important trends in the U.S. food market that affect the "future profitability and export opportunities of Canadian producers of groundfish products."[1] A new Canadian report evaluates these trends and opportunities.

It was prepared in the Agriculture, Fisheries, and Food Products Branch, Department of Industry, Trade and Commerce, by G. W. Raynes under the supervision of A. J. Hemming. It is titled: "Developments in the United States Food Market and Their Significance for Canadian Groundfish Products." The sponsors hope it will help Canadian industry adjust to the changing structure of U.S. market.

The report discusses the traditional retail sector--but focuses on the booming food-service market, particularly the dynamic fish-and-chip industry. After only 5 years, this industry exerts a "significant influence on the demand for cod."

The Canadian investigation of trends in the U.S. food market and their implications for groundfish products is based largely on 132 interviews in major geographic regions in 1970.

The investigation was directed toward major retail food chains, food-service operators, and the fish-and-chip franchises in particular. For the Canadian processing industry, these are primary sources of present and future demand for groundfish products.

The 34 retail chains surveyed operated 19,000 stores and accounted for over 35% of U.S. retail food sales. Eleven of the 12 leading chains were included. Dominant firms in major sectors of the expanding food-service market were surveyed; in fish-and-chip sector the companies interviewed accounted for an estimated 75% of the industry's total sales.

[1] Among major groundfish species are cod, haddock, flounder.--Ed.

THE UNITED STATES FOOD MARKET

Trends in Food Consumption

The proportion of the per-capita disposable income U.S. spent on food is declining steadily, but the absolute level of food spending continues to grow as population and disposable income grow. Between 1950 and 1968, U.S. population increased at annual rate of about 1.7%; disposable income expanded 185% to $590 billion. These trends more than offset a 23% decline in the proportion of per-capita disposable income spent on food; total consumer spending on food and beverages increased 116%. In recent years, spending for food and beverages has been increasing about 5% a year.

Relative Importance of Food-Service Industry

Retail food stores are selling about $62 billion of food, excluding beverages. The comparable figure for food-service[2] sector is about $28 billion per year. The latter, however, is expanding more rapidly. Between 1960 and 1966, the average growth rate in food-service sales was about 10% per annum. By 1977, it is estimated, food sales by food-service industry will be about $50 billion compared with $87 billion in sales by retail sector. By 1980, the food-service market could achieve over 60% of all food sold in U.S.

There is a growing trend in the U.S. to "eat out." Many factors are responsible, including especially:

(a) Higher disposable incomes and raising of median income. In 1967, the median family income was $7,974, compared with $4,611 in 1950. By 1980, 50% of U.S. households are expected to have incomes of at least $10,000 per year and account for 75% of personal income.

(b) More women are working. By 1980, their number will have increased by 4 million to about 20 million.

[2] Food-service sector included 370,000 establishments in 1966: table-service restaurants, cafeterias, counter service, drive-ins, drug and retail stores, etc.

Almost one of every three dollars spent on food in the U.S. is spent on food eaten outside the home.

More Demand for Convenience Foods

There has been a significant shift toward convenience foods. These are products ready to serve, or require only secondary heating or other preparation. Estimates are that retail sales of convenience foods alone reach $36 billion a year. This places them in a dominant position in U.S. market. Sales of foods with built-in convenience are growing substantially faster than basic commodities. The trend favors heat-and-serve convenience foods in retail and food-service sectors, particularly in the latter.

The Frozen Food Market

Frozen food is the category most affected by boom in demand for convenience foods. It has been growing fastest. Between 1960 and 1968, the retail value of frozen food sales increased 115%; total food sales, up 28%. More significant, there are important shifts in relative importance of frozen-food categories and in food-service sales relative to retail.

Demand is shifting from relatively basic commodities to products with greater convenience. In 1967, per-capita spending on frozen foods increased just over 2%; spending on prepared foods rose almost 9%. This rate of per-capita increase exceeded greatly all frozen-food categories, except meats. Within the product class, frozen dinners attracted highest per-capita expenditures and grew faster than any other prepared food.

The food-service frozen-food market is growing in importance. In 1967, per-capita spending on food-service frozen foods increased over 4%, compared with under 1% for retail frozen foods. The food-service share of current annual market for frozen foods is $2.6 billion, compared with $7 billion in retail sector. Annual food-service sales of frozen prepared foods, such as entrées, are now $249 million.

The minimum percentage growth in sales of prepared foods between 1968 and 1980 should be 84%; for all frozen foods, a 67% rate of growth is projected. Prepared foods are the major category of frozen foods. In 1968, sales were $1.14 billion; projected minimum sales of $2.37 billion in 1980 would retain this position.

The motivation for industry's increasing orientation to frozen convenience foods comes primarily from need to minimize labor costs and from problems connected with unskilled kitchen help. Industry views these as major problems. For the housewife today, the decision to buy convenience foods is largely a matter of preference and tastes; for food-service operators, the use of convenience foods is dollars and cents, the need to remain competitive.

The shift to convenience foods is more rapid in food-service sector than at retail level. In the home, any additional cost is not connected so closely with labor saving as for the food-service industry, where time saves money. Convenience foods offer other advantage to food-service operators: "they can provide the basis for expanded menus, improved cost and quality control, lower inventories, savings in space, reduced cooking time, more rapid service, and the efficient use of unskilled labor."

The Frozen Seafood Market

The trends in the food market apply with at least equal force to the seafood market. More than half the seafood marketed is now sold frozen; the conservative demand projection indicates sales of frozen seafoods should expand by at least 107% between 1968 and 1980. Frozen convenience foods range from ready-to-serve seafood dinners, entrées and other precooked items to frozen portions and fillets, where major growth potential is concentrated. Between 1968 and 1969, estimated retail and food service sales, in pounds, of fish sticks rose by 24% and 20% respectively, while fillets expanded by 16% and 17%. Both retail and food-service sales of fish portions expanded by 21% in 1969. This contrasted sharply with trend between 1960 and 1968, when average annual growth in frozen seafood in dollar terms was minus 0.3%.

Whereas the United States retail sector is the major source of demand for food as well as for frozen foods in total, the food-service sector is already the major source of demand for frozen seafoods. In 1969, total food-service sales of frozen seafood--excluding seafood specialties or bulk fish shipped and sold fresh by dealers--were over $862 million, compared with retail sales of $464 million.

Food-service sales of specialty seafoods are now 48 million pounds a year; sales of entrées, which include seafood items, are about 50 million pounds.

The demand for frozen groundfish products is more evenly divided between retail and food service. Combined sales of fish portions, sticks, and fillets total estimated $140.3 million in food-service sector and $197.8 million in retail sector.

The Market for Groundfish Products

Like the market for frozen foods generally, the U.S. market for frozen seafoods, including groundfish products, is growing dynamically in area of convenience products. This is attributed to combined stimulus of changes in consumer attitudes and incomes, new markets in food-service sphere, and more emphasis on innovation by processors in this age of convenience foods.

While retail food chains foresee expansion in demand for frozen groundfish products, and in breaded-and-battered items in particular at retail level, the food-service industry, especially the fast-food fish-and-chip franchises, will be the major source of future growth. This was confirmed by wholesalers and other distributive organizations: Some now concentrate on catering to requirements of food-service users of frozen fish; and also by the projected expansionary plans of the fish-and-chip franchises.

This optimistic view of future demand for maximum-convenience frozen groundfish products contrasts markedly with attitude of the great majority of retail food chains toward fresh fish. Although 80% of retail chains interviewed operated fresh-fish departments, these were not expected to grow rapidly because consumers, more and more, prefer frozen fishery products. Some fresh-fish departments are now unprofitable because of rising labor costs but are operated as convenience to buying public. One reason the fresh-fish department lacks growth potential is that it has remained outside mainstream of product innovation.

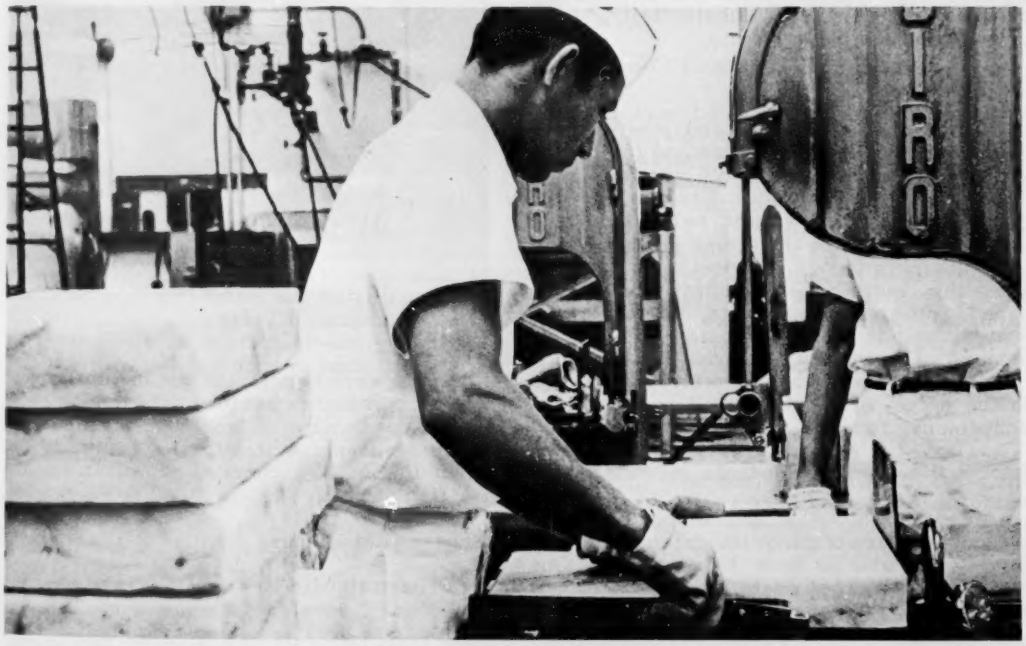


Fig. 1 - Production of Breaded Fish Portions. A series of cuts with high-speed saws turns blocks into uniform portions desired.

THE RETAIL FOOD MARKET

Frozen Foods

Frozen foods are the food category most affected by upsurge in demand for convenience foods. They have the greatest relevance for groundfish products. They now account for 5.2% of total food sales of U.S. supermarkets. It is estimated that this percentage will rise to 7% by 1975, and to 8.3% by 1980. A major impediment to growth of frozen foods at retail is lack of display space, together with insufficient zero-degree space in company warehouses.

Freezer space inhibits sale of fish products. The freezer space allocated to fish by First National Supermarkets ranges from 4 feet 2 inches by 7 feet, depending on total freezer capacity of the individual stores. The proportion of total space for fish products is 7%; fruit 3%; frozen meats 4%; potatoes 7%; dinners and meat pies 11%; concentrates 12%; bakery products 16%; frozen vegetables 27%.

The freezer space in new and remodelled stores is being expanded substantially, up to three times the old system.

Convenience Products

The retail food chains and other buyers have connected expanding demand for frozen groundfish products with the availability of convenience-type products. Nearly all supermarket buyers interviewed believe convenience foods will be the future growth center in retail frozen foods. Supporting this growth are: the continued introduction of new prepared, frozen-food products, more working women, and increasing income of U.S. consumers. The eventual introduction of rapid-heating equipment, such as microwave ovens in the home, will make it still easier to use convenience foods.

Introduction of New Products

About 18% of retail frozen-food sales did not exist or were of minor importance in 1965; this figure will be near 35% by 1980. One major supermarket chain introduced 26 new seafood products in 1970; consumers were extremely receptive. By 1980, the average supermarket will handle about 800 frozen food items, compared with 375 to 450 now. Also, there is a growing market for premium-quality frozen foods.

Growth Potential for Groundfish Products

Precooked breaded-and-battered items, especially portions, and dinners and entrées, hold the greatest potential for groundfish products. Retail sales of these products, with some exceptions, were "buoyant". New precooked convenience items with much consumer appeal are largely responsible for sales growth. They are of primary importance to future of seafoods in U.S. market.

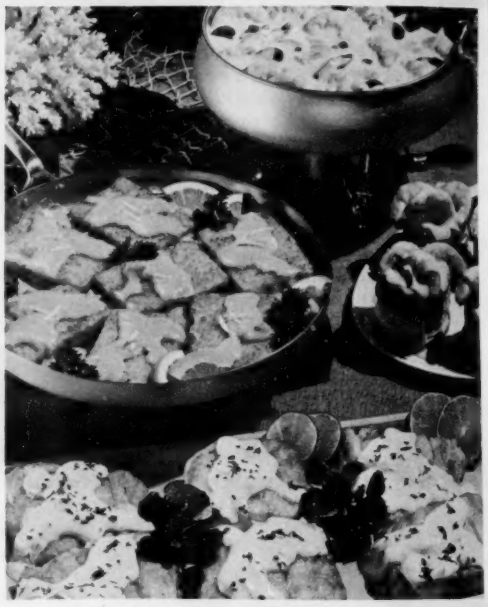


Fig. 2 - Fish Portions.

Quality

There were no negative comments on quality of convenience seafood products as such, except for some on batter-content. This contrasted sharply with situation in late 1950s, when low quality checked growth in demand for fish sticks.

Frozen Diet Dinners

Frozen diet dinners, unsuccessful when introduced in 1950s, now are popular. This resulted from greater concern among U.S. consumers about coronary diseases and publicity about fish's nutritional advantages. These dinners use such groundfish species as haddock, flounder, and cod.

Seasonal Fluctuations in Seafood Sales

The 6-week Lenten season remains the peak selling period for seafoods. On national basis, however, sales now are much more evenly distributed over the year. Combined Lenten sales of seafoods in 7 major markets have been about 10% of annual sales; monthly sales during rest of year ranged between 6.7% and 8%. There were secondary peaks during Thanksgiving and Christmas periods. Supermarket chains have spread their seafood promotion over the year to coincide with these trends.

However, within the U.S. pattern, monthly distribution varies markedly from market to market. In 1969, for instance, sales in Detroit, Mich., peaked during Christmas season; in Atlanta, Ga., annual sales were lowest then.

Supermarket sales used to peak on Fridays; now they are more evenly distributed throughout week.

Distribution of Seafood Products

Except for private label, the supermarkets do not carry anywhere near a full line of a seafood brand. No brand, except Mrs. Paul's, is distributed nationally. The chains with private labels tend to view other brands as complementary to theirs.

Impact of Food Service Sector

The retail sector is more concerned at the growing diversion of potential retail food sales to food-service industry, especially to fast-food sector. Take-out sales now total almost $1.5 billion a year. To supermarkets, take-out sales in particular are purchases that traditionally would have been theirs.

As consumption of foods prepared away from the home grows, the supermarket chains are acting to get their share:

1. Some have established food-service divisions. The chains already have warehouses and delivery facilities and can offer one-stop distribution.

2. They offer hot, ready-to-serve, take-out foods. About 60% of supermarkets open last year had these sections. However, this trend is still in its infancy.

If the present trend continues, delicatessens will be the focus of supermarket expansion in take-out foods.

3. Competing directly with fast-food operators. Several supermarket chains have specialty restaurants.

Product Specifications

An important segment of buyers, the largest retail buyers, insists that processed groundfish products meet rigorous specifications, including packaging. All retail buyers place importance on high quality, at least equal to national brands, the advertising and promotion, and the reputation and consumer appeal of the brand. It is expected that product will meet usual standards on absence of bones and be covered by liability insurance.

A new product normally is tested. There are wide variations in thoroughness of testing procedures. The general tendency is for large retail buyers to test product thoroughly and for medium-sized chains to rely on brand reputation.

Criticism of Canadian Groundfish

Criticism by retail buyers of Canadian groundfish was not significant statistically. It was confined to bones and texture. The Canadian product was compared unfavorably to Icelandic commodity. On eastern seaboard, buyers for retail chains assume that products are boneless to a degree acceptable to the consumer. They merely require seller to have liability insurance to cover claims arising from sale of products containing bones. In western states, buyers expect products to be completely free of bones.

Purchasing Practices

Chains make little use of wholesale distributors. The major method of buying the frozen product is direct buying--from processors or through their broker representatives.

Merchandising

Eighteen retail outlets were inspected for merchandising of seafoods. No clear pattern emerged. In freezer space and in-store merchandising, the promotion of seafood could not

be rated "completely inadequate," simply dull. Generally, management still considers frozen seafoods low-interest items.

The expansion of retail demand for frozen groundfish products will depend heavily on product innovation.

Private Label

Over half the retail food chains had their own label in certain seafood items. While it was found that chains of similar size had differing philosophies on private labelling, there is a functional relationship between the size of the chain and the use of private label by major retail food organizations. Some 75% of chains with over 90 retail outlets carried their own private label; only 36% of smaller chains. When members of Topco Associates, a major group buying organization, are excluded, the latter percentage falls to 14%.

Selling Performance of Canadian Producers

Excluding the three largest chains, no major retailers stated that Canadian or other foreign producers of groundfish products had established direct and significant relationships with them. And none was critical of this.

Canadian processors of groundfish products concentrate sales function in the hands of brokers. This is how Iceland and other producers supply retail food market. The selling performance of Canadian producers is as good as their foreign competitors'.

As demand turns more to sophisticated processed products, volume sales are concentrating in hands of large food brokers, especially those who service food-service sector. These firms have specialized selling techniques necessary for high sales performance. So large brokers are becoming the major selling channel for Canadian processors. The small traditional brokers may be reduced to a marginal role.

THE FOOD SERVICE MARKET

Scope of Market

The food-service market, in 1966, had over 370,000 establishments: table service restaurants, cafeterias, counter service, drive-ins, drug and retail stores; industrial, hotel, motel, recreational and amusement places for eating; hospitals, nursing homes, schools, colleges, universities, and military establishments.

Public eating places account for about two-thirds the total retail value of food sold by food-service industry. Sixty percent of these places are separate establishments; the remainder are part of other businesses--variety stores, hotels, motels. Nonpublic eating places account for about one-third the retail value of food sold by food-service industry: schools, hospitals, and homes for children, the aged and the mentally ill.

Fast-food service offers some convenience in eating. It accounts for 80% of U.S. food-service business; the value of annual food sales by service restaurants is only 20%. Service restaurants provide table service in a dining room, have extensive kitchen facilities, a professional chef, and offer full courses.

The food-service industry is growing about twice as fast as the retail food sector. The industry is substituting capital for labor, and production-line labor for skilled labor.

Average sales per employe in food-service sector is $8,500; they are about $18,000 for supermarket employe, and $22,000 in average retail outlet. Wages are rising at 2.3% annual rate, considerably above growth in productivity. The upward trend in wages in the food-service industry is accelerating.

The evidence points to steadily increasing use of convenience foods, particularly frozen form. In long run, this probably will be produced in commercial processing plants instead of commissaries.

Demand for Seafood

The consumption of seafood, excluding seafood specialties, by food-service sector is estimated at 680 million pounds a year; of these, 250 million pounds are used by restaurants, 115 million pounds by school-feeding sector.

Frozen groundfish sticks, portions, fillets, entrees and other convenience products of the heat-and-serve variety are gaining increasing acceptance among food-service operators. However, the major growth in volume is concentrated (except for fish sticks) in uncooked breaded portions and fillets.

Fig.

Fig. 3 - Fish sticks passing from batter to breading.

At present, the primary growth area for groundfish products is the fast-food sector of the industry: drive-in and take-out restaurants. The fish-and-chip sector of this industry uses only frozen fillets and uncooked unbreaded portions; other fast-food operators, much less oriented toward use of fish, primarily use breaded or battered portions, generally uncooked.

There has been growing demand for fish portions, now 15 times that for fish sticks in food-service sector. Major reasons are: popularity of fish sandwich, introduced in 1964; portions permit precise serving and cost control. The rise in U.S. consumption of fish portions closely parallels growth of drive-in restaurants.

The large chains in this category, McDonalds and Burger Chef, use substantial amounts of fish portions: each about 10 million pounds a year.

The demand for groundfish fillets and portions developed spectacularly with growth of fish-and-chip franchises in U.S. The story began in 1965, when Haddon Salt established his first outlet at Sausalito, near San Francisco. By the end of 1970, the industry had an estimated 1,150 outlets use groundfish at annual rate of 54 million pounds. Industry consumption in 1970 is estimated at 46 million pounds.

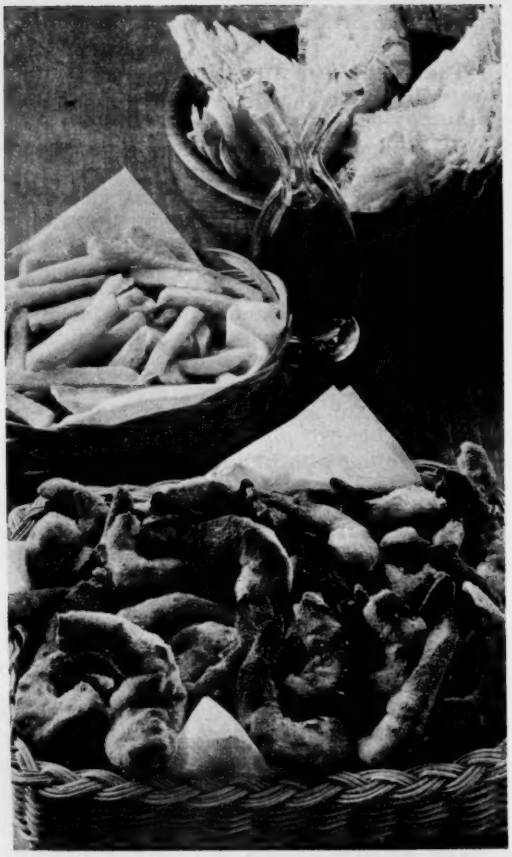


Fig. 4 - Broiled Breaded Shrimp.

The Fish-and-Chip Industry

Like other sections of the U.S. fast-food industry, the fish-and-chip firms are franchise operations. The franchise concept permits companies with limited capital to expand rapidly.

There is a trend toward company ownership of units because this offers the prospect of much greater net returns than royalties from independent franchise operations.

The largest concentration of fish-and-chip outlets is in the western United States; the lowest in the midwest.

The companies cater to sit-down and take-out trade.

Raw Material

The species of fish used almost everywhere by the fish-and-chip industry is cod, primarily because it is relatively low cost.

The Coldwater Seafood Corp. is the dominant supplier of cod to the industry because of the high quality of the Icelandic product and its "aggressive development of this market from its inception."

No firms were located within the fish-and-chip industry that knowingly use cod from Canada. The companies reported that Canadian suppliers had no interest in servicing the industry.

The feeling within the trade is that Canadian cod is inferior to Icelandic and Norwegian cod. Burger Chef, with over 1,000 outlets and annual use of over 10 million pounds of cod portions annually, will not knowingly buy Canadian cod.

"The defects cited range from the presence of parasites, pinbones, skin, black spots, belly-flaps and napes in fillets and blocks, to soft texture and unsatisfactory flavour."

The great majority of companies interviewed did not have first-hand experience with Canadian cod.

The Icelandic block of fillets is smooth. The Norwegian product contains fillets out of shape and difficult to portion. This impedes development of an efficient in-store portioning technique.

The industry believes Iceland can supply all requirements for the foreseeable future. The smaller companies have tended to accept this assurance at face value. Three major companies are very concerned about the future availability of cod; two of them have attempted to find more sources of supply. The industry is more receptive to the prospect of using Canadian cod--providing minimum specifications can be met.

It is estimated that by 1975 the annual raw material requirements of the industry will be 155 million pounds, over 3 times the estimated level of demand in 1970.

It is estimated that there will be 3,250 fish-and-chip outlets in the U.S. by 1975.

The fast-food industry, the major user of groundfish in the food-service sector, has been largely neglected by Canadian processors.

SURVEY FINDINGS AND RECOMMENDATIONS FOR ACTION

(1) Demand

The food-service sector will be the focal point of long-run growth in demand in U.S. food market. Convenience foods will be product group with greatest growth potential. "This conclusion is also applicable to the long-run demand for groundfish products."

The important factors in U.S. demand for groundfish products are:

(a) The fresh-fish market is relatively static. Growth in demand for groundfish products is concentrated in frozen-food sector.

(b) Retail and food-service demand for frozen groundfish is expanding, but growth potential is much greater in latter area. This results from growth of institutional catering and fast-food franchises based on the sale of battered-and-breaded fish products.

(c) The products in growing demand are primarily those with high degree of convenience and product innovation. More consumers like them and they meet specialized requirements of food-service buyers. The major exception to the rapidly growing demand for precooked breaded-and-battered groundfish products is the fast-food industry. But even this sector requires the convenience of precut portions, breaded or raw, as well as standardized fillets.

Another convenience food, fish sticks, is experiencing a slower growth rate than portions. But it is second only to portions as groundfish product in greatest demand in dollar and volume terms on U.S. market. U.S. production of portions and fish sticks, based on supply of foreign raw material, rose from

60,061 tons and 69,903 tons in 1960 to 216,453 tons and 113,338 tons in 1969. Portions, stimulated by expansion in food-service demand, showed uninterrupted annual growth.

U.S. imports of fish sticks and portions from Canadian sources have been insignificant in terms of total market demand. The situation resulted primarily from tariff barriers. It may now be opportune for Canadians to examine thoroughly "the economic feasibility of greater processing of convenience groundfish products for sale in the U.S. market."

The bulk of the demand in the future may be for completely bone-free fish. This and demand for premium products suggest that Canadian producers should up-grade their standards.

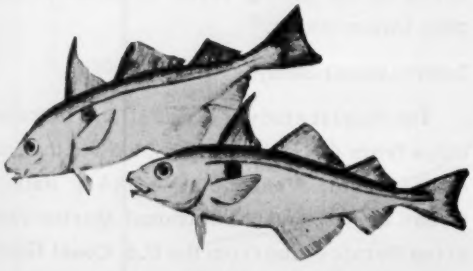
Product Innovation

Improved quality and product innovation to meet buyer desires for more convenience in food products are the "prerequisites for the expansion and maximization of the market share of the Canadian groundfish industry in the U.S. market."

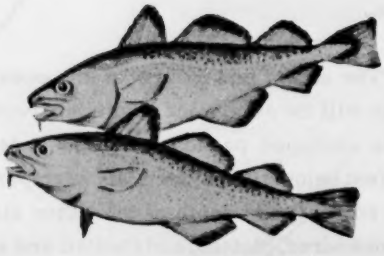
"The available statistical evidence suggests that the market importance of many high-value seafood products, such as flounder, sole and halibut, in their predominant retail forms can be expected to decline within the next decade. This long run trend can be expected to continue unless new and more popular products are developed, particularly frozen, highly processed convenience items."

In the U.S., most of the companies that were engaged directly in the supply of fresh fish 20 years ago have gone out of business. Firms that relied on the markets for frozen fish and/or fillets have had trouble remaining solvent. But specialty companies that have used the basic raw material to produce the precooked fishery products have thrived. The largest seafood processors are product manufacturers rather than packers of commodities. "Such growth as the U.S. fishery industry has achieved over the past 20 years is directly attributable to the introduction of convenience type products."

Flounder



Haddock



Cod

OCEANOGRAPHY

INTERNATIONAL STUDY OF CARIBBEAN CURRENTS IN JULY & AUGUST

The 3-year, 15-nation oceanographic investigation of the Caribbean and Gulf of Mexico has a new phase scheduled for July and August. U.S. scientists and ships are participating. Its main objective is an intensive study of the circulation patterns to determine which processes cause them. The U.S. efforts, mainly by NOAA, will concentrate in the western Caribbean, Yucatan Channel, and southeastern Gulf of Mexico.

Trade Winds & Ocean Currents

Scientists think the trade winds over the tropical Atlantic and Caribbean are the prime movers of the ocean currents in the Caribbean, Gulf of Mexico, and the Florida Straits. It is unclear, however, how this input of wind momentum is organized into an ocean current. One assumption is that the input first drives a series of eddies which, in turn, drives the larger-scale currents. An older hypothesis is that the western Caribbean currents are driven directly by the winds to flow uphill against gravity. And there are other assumptions.

The Operation

"The extent and nature of the ocean currents will be determined by radar tracking of radio-equipped parachute drogues deployed 120 feet below the surface. The temperature, salt content, and depth of the water also will be measured, plotted, and studied and examinations made of the distribution of certain trace metals. The deep-water tides will be studied by current meters moored close to the ocean bottom. And the temperature, speed, direction, and humidity of air currents and the nature of clouds will also be investigated to provide background for an understanding of the interaction between the sea and the atmosphere."

Dr. Harris B. Stewart Jr., of NOAA's Atlantic Oceanographic and Meteorological Laboratories in Miami, Fla., is U.S. National Coordinator for the project, known officially as the Cooperative Investigation of the Caribbean and Adjacent Regions (CICAR). He said that in previous efforts little more than one-ship scientific work had been done.

"The Caribbean Sea with its adjacent Gulf of Mexico is, oceanographically speaking, still poorly described and even less well understood," he stated. "Now, its dynamics, its contained life, its bottom topography and tectonic framework, its interactions with the overlying atmosphere, and the dynamics of the atmosphere above it are the subjects of a cooperative international investigation sponsored by the Intergovernmental Oceanographic Commission."

International Study

The August study of circulation will include ships from Colombia, Cuba, Mexico, the United Kingdom, Venezuela; NOAA's National Ocean Survey and the National Marine Fisheries Service; and from the U.S. Coast Guard.

About 15 NOAA scientists will work aboard two floating oceanographic laboratories of the National Ocean Survey, the 'Discoverer' and 'Researcher'.

CLAMS: Resources Are Healthy, Says J. P. Wise

[The April 1971 Commercial Fisheries Review (CFR) included: "Ocean Quahog Becomes More Important As Surf & Bay Clams Dwindle." The article was based on information from the New England Marine Resources Program. The program is supported by the Sea Grant College and Program Act, the State Technical Services Act and the University of Rhode Island. . . Ed.]

John P. Wise, NMFS Tropical Atlantic Biological Laboratory, Miami, disagrees with the statement that clam resources are dwindling. He writes: ". . . this is in fact not the case. I have enclosed some tables and graphs on surf clams, hard clams, and soft-shell clams, extracted from official NMFS statistics, that seem to show that the fisheries are in healthy shape with increasing catches over the last several years. (The apparent decline in hard clam catches in the early 1950's was caused by a temporary upsurge in landings in the late 1940's and early 1950's.)

"A minor point is that Spisula soldissima is almost universally known as 'surf clam' not 'sea clam'."

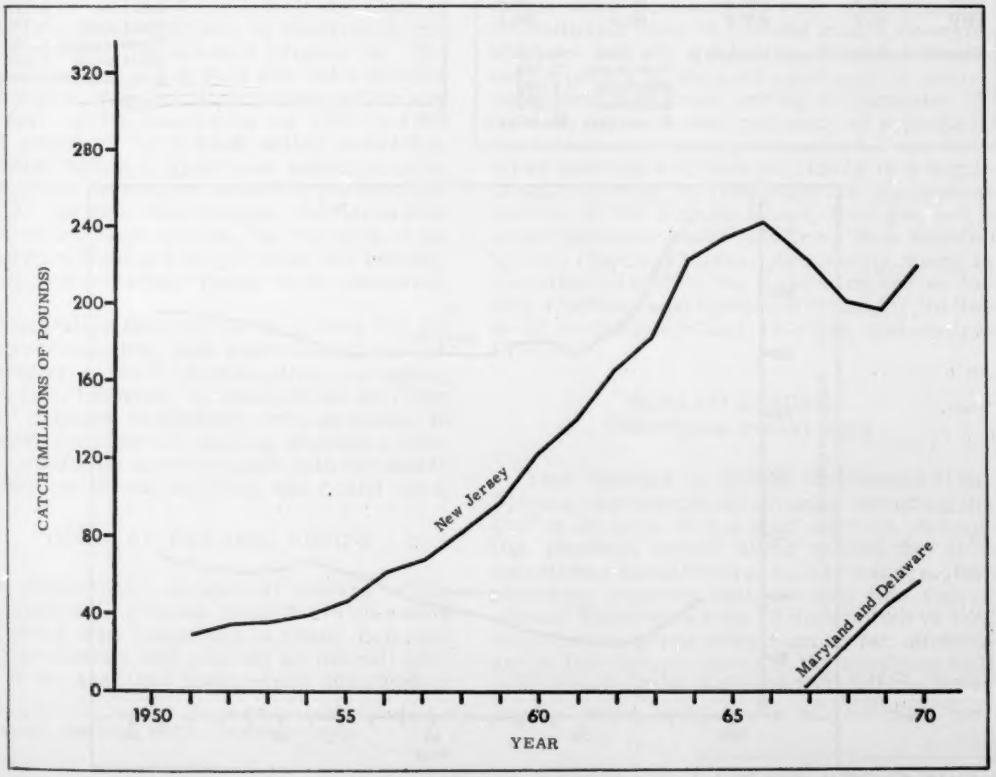


Fig. 28A.1 - Surf clam catches in certain states, 1951-70 (smoothed by moving average of 3).

Table 28A.1 - Catch of surf clams landed in various states, 1945-70

Year	New York	New Jersey	Delaware	Maryland
	millions of pounds (whole)			
1945	18.7	2.8	-	-
1946	30.5	-	-	-
1947	14.8	.9	-	-
1948	16.9	.9	-	-
1949	23.1	2.2	-	-
1950	15.5	22.8	-	.5
1951	19.0	33.9	-	-
1952	19.5	94.0	-	8.5
1953	15.7	36.4	-	10.0
1954	15.8	36.4	-	5.5
1955	9.5	43.8	-	6.9
1956	11.1	61.3	Ø	7.6
1957	7.5	80.6	.2	3.8
1958	2.0	66.0	.8	3.2
1959	2.4	106.7	1.7	3.5
1960	3.4	124.1	.5	1.7
1961	3.4	141.3	-	.3
1962	3.9	157.9	.4	.3
1963	4.6	199.8	-	.3
1964	5.7	195.2	-	.2
1965	7.0	224.0	-	1.1
1966	8.7	228.6	-	Ø
1967	10.8	220.1	-	.1
1968	14.2	170.4	-	21.8
1969	16.1	190.8	11.3	29.2
1970	18.3	209.6	12.3	56.1

Conversion factors (meats to whole): New York 4.706; New Jersey 5.294; Maryland 4.092; Delaware 4.092

Ø less than .05 million

Table 28B.1 - Catch of various clams, 1950-69

Year	Hard clam	Soft clam	Razor clam	Ocean quahog	Other
	millions of pounds (whole)				
1950	177.9	42.7	5.9	1.8	.6
1951	175.9	41.1	6.5	1.6	.3
1952	148.6	33.4	4.1	3.9	.2
1953	143.5	25.8	4.5	2.2	Ø
1954	114.3	23.3	3.8	1.6	.5
1955	125.4	23.3	5.7	3.6	.1
1956	124.2	27.8	2.3	3.1	.2
1957	124.8	26.0	2.4	3.1	.1
1958	120.7	30.0	1.8	2.1	.1
1959	114.6	32.5	2.3	.8	.1
1960	125.8	39.0	1.9	1.5	.2
1961	123.5	33.5	1.7	1.0	.1
1962	112.4	42.8	1.2	.5	.1
1963	122.8	44.4	1.0	.8	.1
1964	126.2	50.2	.6	.9	.1
1965	127.2	51.5	.7	.7	Ø
1966	129.5	54.2	.6	.7	.3
1967	136.8	44.7	.7	.4	.5
1968	130.4	47.2	.5	1.8	2.3
1969	137.2	61.3	.6	5.1	3.4

Conversion factors (meats to whole): Hard clam 8.454; Soft clam 4.551; Razor clam 2.334; Ocean quahog 8.000; Other clams 5.000

Ø less than .05 million pounds

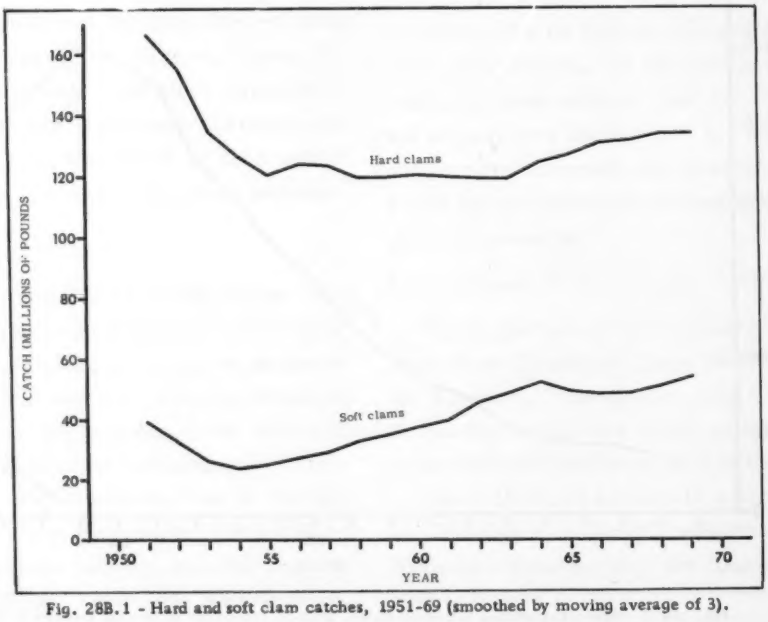


Fig. 28B.1 - Hard and soft clam catches, 1951-69 (smoothed by moving average of 3).

DISTRIBUTION OF SOME COASTAL PELAGIC FISHES IN THE WESTERN ATLANTIC

Edward F. Klima

The coastal pelagic resource of the Gulf of Mexico and South Atlantic is presently underutilized--mainly because it occurs in many small, fast-traveling schools that cannot be harvested by conventional fishing. The Pascagoula Exploratory Fishing and Gear Research Base has been developing harvesting systems for this vast resource (Klima, 1970). This paper summarizes the scant information available on its distribution and abundance.

I have used the exploratory catch data collected since 1950 by the Pascagoula Fishery Center to provide some idea of the magnitude and distribution of the coastal pelagic resource in the Gulf of Mexico and western Atlantic. The Atlantic, including the Gulf of Mexico and Caribbean Sea, is subdivided into 27 exploratory fishing zones (Figure 1). Unfortunately, sufficient data are not available to describe seasonal distribution within any one year, so the catch data for 1950 to 1969 were combined by season within subareas. Variation within a year was assumed to be unimportant in terms of seasonal distribution trends. To describe roughly the seasonal depth-distribution trends, the records of all exploratory fishing with gill nets and bottom, shrimp, and midwater trawls were combined.

Quantitative data are not available for the species discussed, and each fishing record represents a valid identification. Grouping these data, however, is assumed as an index of the relative availability of a species. In addition, commercial landing statistics provided additional distributional data for Spanish sardine, thread herring, and round scad.

COASTAL PELAGIC FISHES

A preliminary acoustical survey of the coastal schooling fishes from North Carolina to Florida was conducted in 1968. Selected data (Drummond, MS) provide an overall picture of the seasonal north-south distribution of the midwater schooling fishes from Cape Hatteras to Cape Kennedy. Figures 2, 3, and 4 show the north-south distribution for March, July, and November. In the spring, midwater schools are most commonly located between St. Simons Island, Georgia, and St. Augustine, Florida (transects 17 to 21), and from south of Jacksonville to south of Cape Kennedy (transects 24 and 25). Generally, few schools occurred north of St. Simons Island.

Summer and Fall

During the summer, midwater schools were found throughout the entire survey area but with much greater frequency in the southern portion. Fish schools were most common off South Carolina; St. Simons Island, Georgia; Mayport and St. Augustine, Florida. There seems to be a slight shift northward in school concentrations from spring to summer. In the fall, there is less frequency of schools in the extreme northern portion from Cape Hatteras southward to Georgia; there is a significant increase in frequency in the central portion off St. Simons Island, Georgia, and a slight increase southward from New Smyrna to Fort Pierce, Florida. Apparently, there is a southward shift in the population during the fall; a definite aggregation of its major portion is off St. Simons Island, Georgia, and central Florida.

SCALED SARDINE
(Harengula pensacolae)

This species is widely distributed from Florida southward to Brazil, including the Gulf of Mexico. It is a near-surface, schooling, plankton feeder along coasts, but it is sometimes found several miles offshore. Exploratory records indicate that this fish is usually found within the 20-fathom curve but, on occasion, it has been seen as far offshore as the 165-fathom curve in the northern Gulf of Mexico (Figure 5) and the 257-fathom curve

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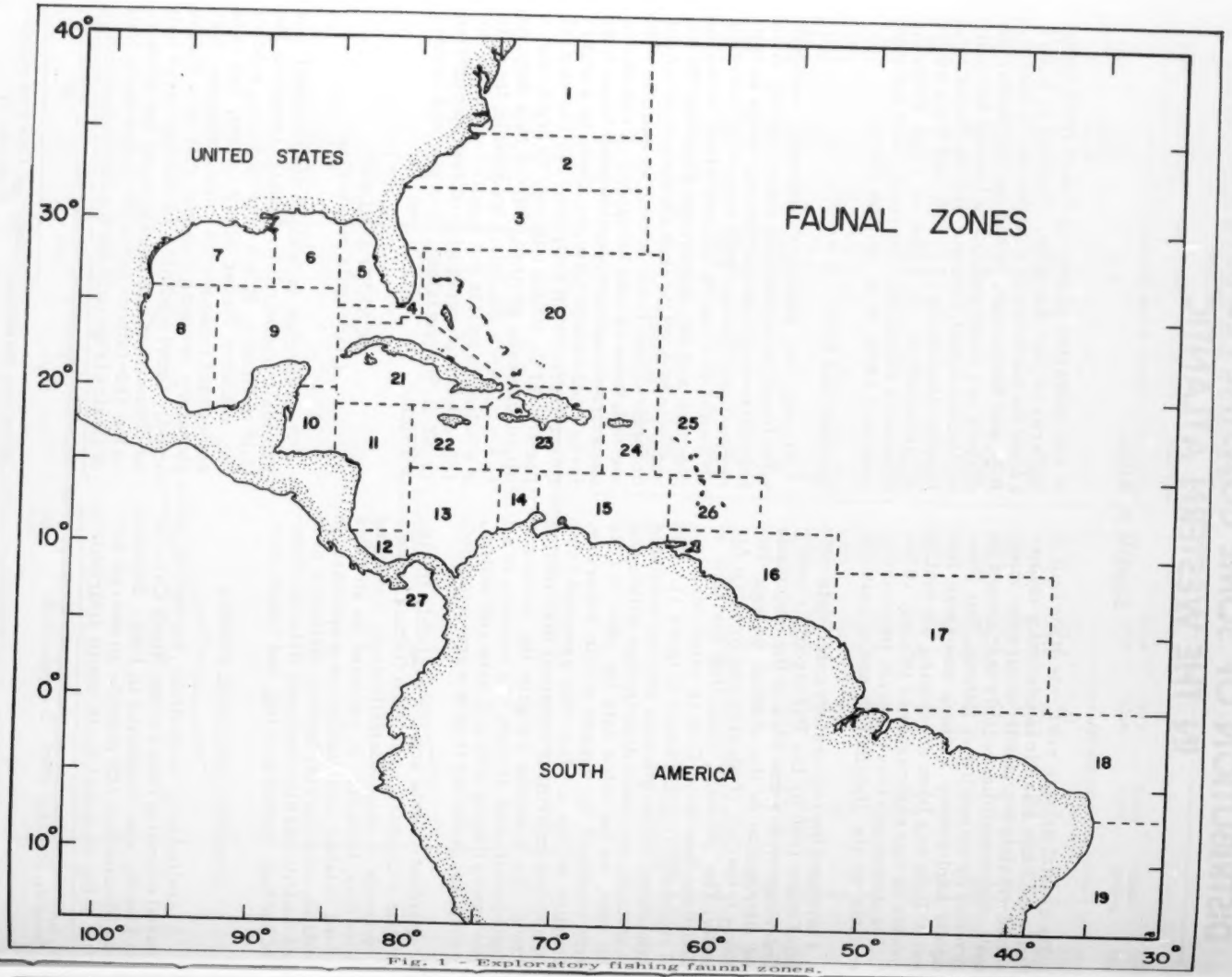

Fig. 1 - Exploratory fishing faunal zones.

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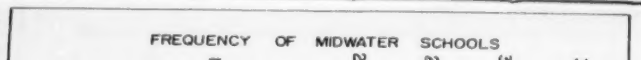

Fig. 2

off Colombia. It may be found with H. humeralis and H. clupeola in the Florida Keys and along the north coast of Yucatan, but it is the only species of Harengula inhabiting the Gulf Coast of the United States.

Scaled sardines are not exploited in the Gulf of Mexico, although they are harvested off the coast of Venezuela (personal communication, Rivas), where they are caught with beach seines and canned for local consumption. In Miami, Florida, they are caught with lift nets around piers and bridges in the fall and winter and sold as live bait (Klima, 1959).

SPANISH SARDINE
(Sardinella anchovia)

It ranges from Cape Cod to southern Brazil, including the Gulf of Mexico, Caribbean Sea, Bermuda, Bahamas, and West Indies. It is normally found close to the coast, well within the 50-fathom curve, but it has been caught as far offshore as the 200-fathom line in the Atlantic.

Roithmayr (MS) has shown that the two western Atlantic forms may be either valid species or seasonal races of a single species. Both forms coexist in the coastal waters of the Gulf of Mexico, Trinidad, and Brazil. Until this taxonomic problem is solved, and for the purpose of this report, it is referred to as Sardinella anchovia.

This silvery-blue fish is harvested with beach seines along the west and northwest Florida coasts for bait in the sport fishery. Yearly production is under 150,000 pounds, worth less than $5,000 (Figure 6). The increasing trend in yield from 1960 to 1968 is more than likely due to an increase in sports fishing; the species is one of the major sources of bait in west Florida. The fishery takes advantage of the numerous schools close to the beach during spring and summer. Usually in late fall and winter, the fish move offshore and probably migrate southward.

Diver observations around submerged structures indicate that this species mixes freely with round scad and, to some extent, with scaled sardine. Fishing captains indicate they catch Spanish sardine and round scad together.

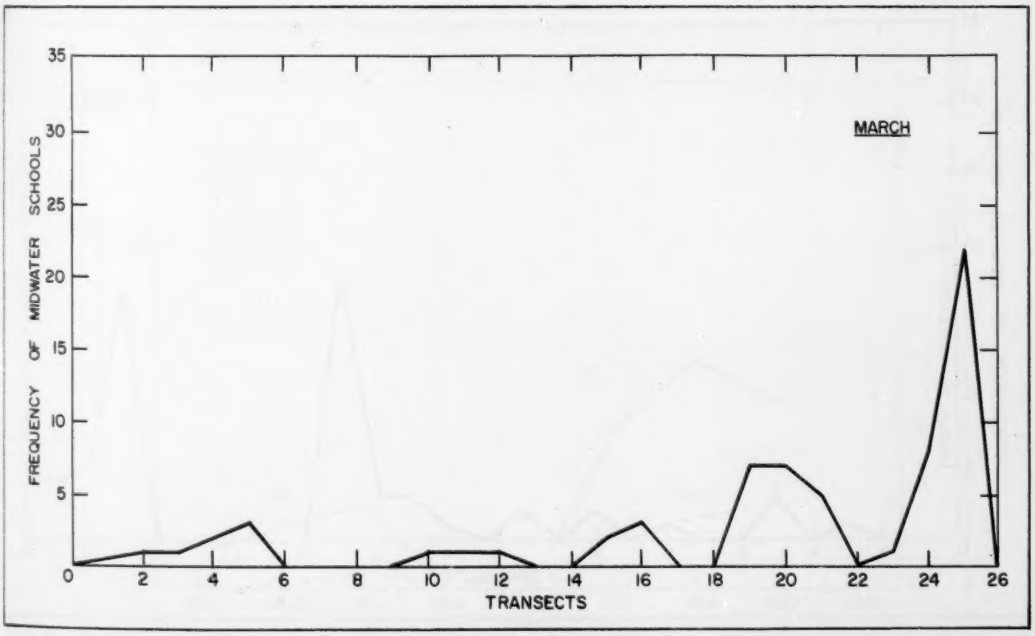

Fig. 2 - North-south distribution of midwater fish schools in March, Transect 1, Cape Hatteras through Transect 26, Cape Kennedy.

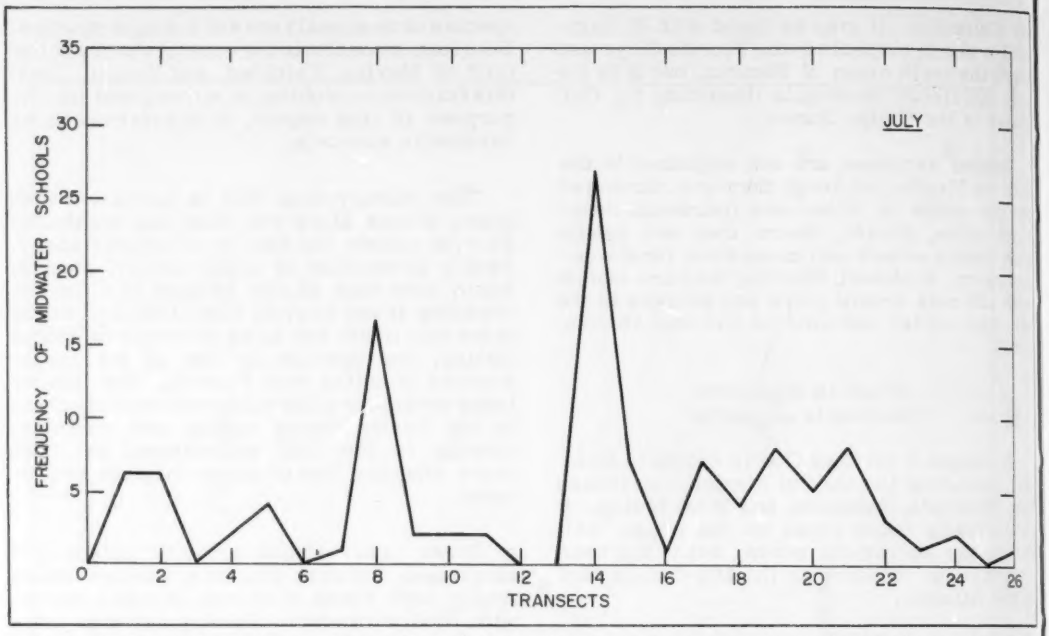

Fig. 3 - North-south distribution of midwater fish schools in July, Transect 1, Cape Hatteras through Transect 26, Cape Kennedy.

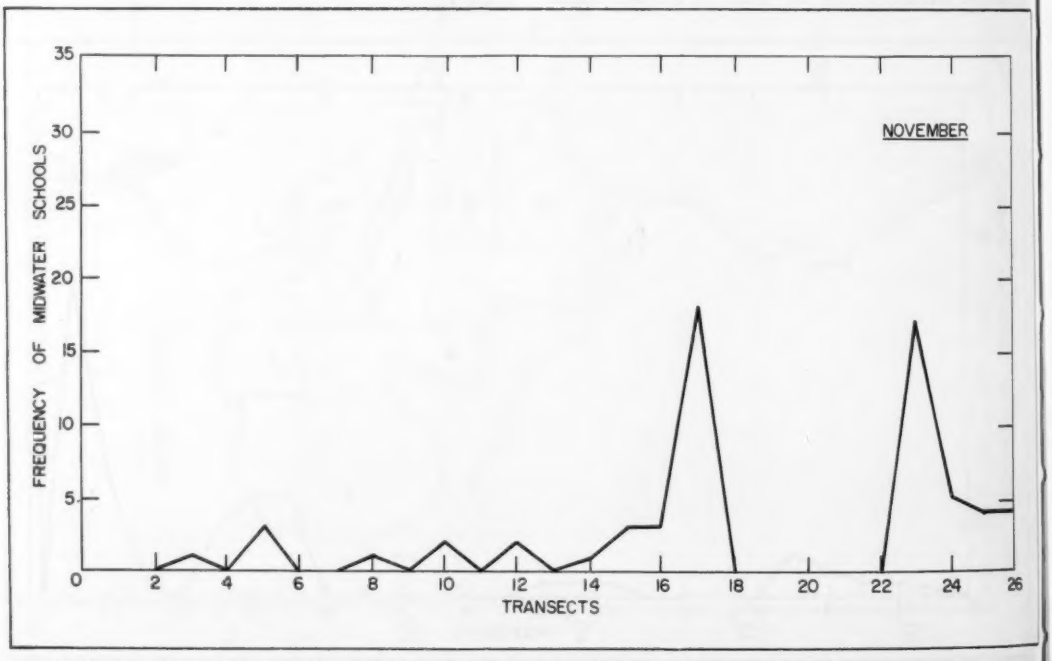

Fig. 4 - North-south distribution of midwater fish schools in November, Transect 1, CapeHatteras through Transect 26, Cape Kennedy.

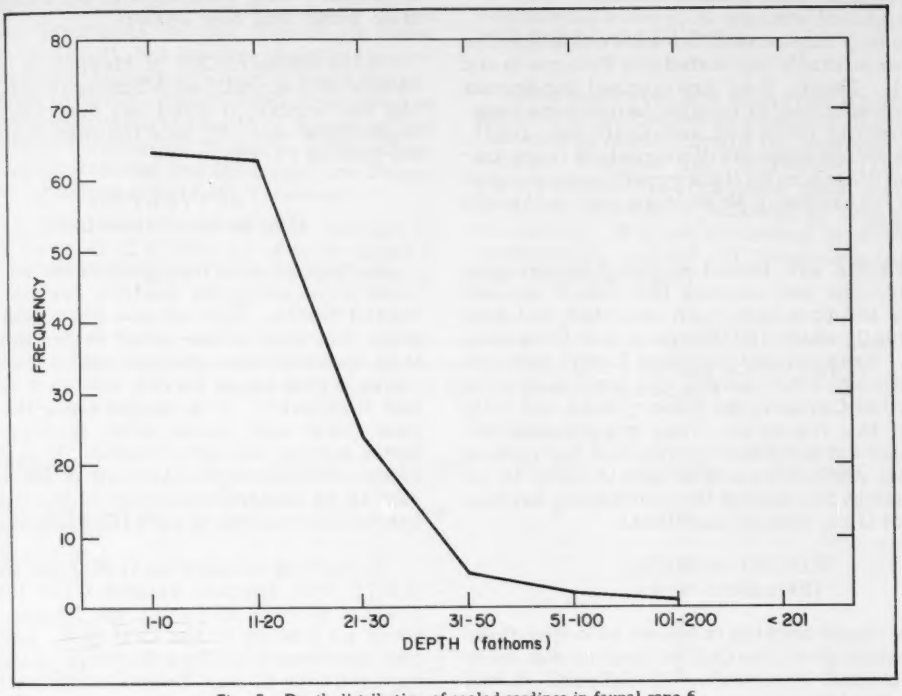

Fig. 5 - Depth distribution of scaled sardines in faunal zone 6.

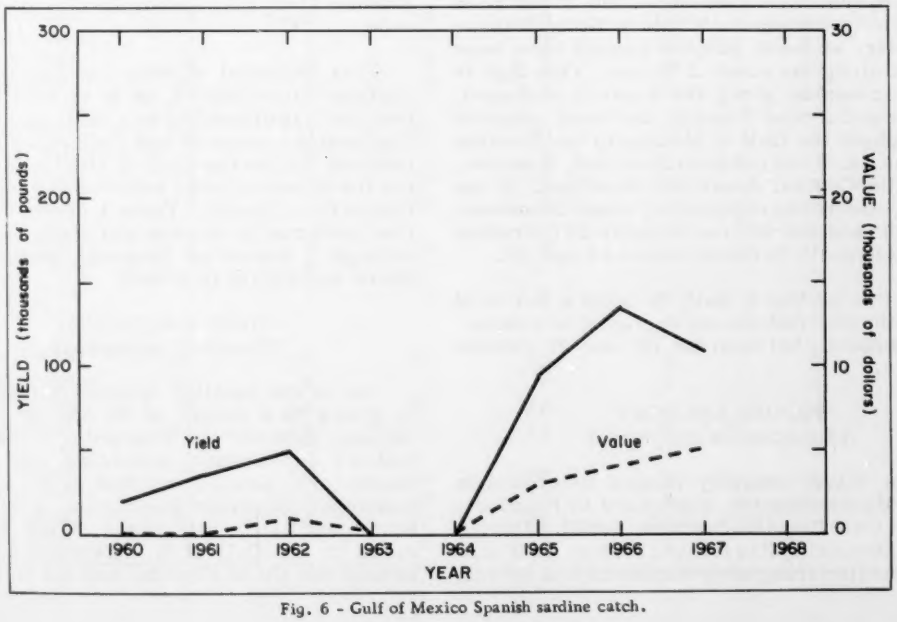

Fig. 6 - Gulf of Mexico Spanish sardine catch.

Harvested in Venezuela & Brazil

The only other countries where this species is commercially harvested are Venezuela and Brazil. There, they are canned for human consumption and/or iced for bait in tuna long-line fishing (Simpson and Griffiths, 1967). This species supports Venezuela's most important commercial fishery with annual catch usually in excess of 40,000 tons valued at about $700,000.

Sardines are fished by beach seines and, usually, one set catches the entire school. Sets of 400 tons have been reported, but sets are usually under 100 (Simpson and Gonzalez, 1967). Simpson and Griffiths (1967) indicate that although beach seines are well suited for the Gulf of Cariaco, the fishery does not fully exploit the resource. They recommend the development of modern and mobile harvesting gear to replace beach seines if there is an increase in demand for the processed sardine product (i.e., canned sardines).

ROUND HERRING
(Etrumeus teres)

The round herring is known to occur from Maine throughout the Gulf of Mexico to at least the Yucatan Peninsula. Hildebrand (1963) states that it rarely occurs north of New Jersey but, several times since 1900, it has been extremely abundant off Woods Hole, Massachusetts; at least 200,000 pounds have been landed along the coast of Maine. This fish is fairly common along the eastern seaboard, southward around Florida, and very common throughout the Gulf of Mexico to the Yucatan Peninsula. It has not been observed, however, along the Central American coastline. It has been collected by exploratory vessels between the 100- and 300-fathom isobaths off Colombia and Venezuela in faunal zones 14 and 15.

In the northern Gulf, it occurs out to at least the 200-fathom curve, but it is concentrated mainly between the 10- and 30-fathom curves.

SILVER ANCHOVY
(Anchoviella eurystole)

The silver anchovy ranges from Woods Hole, Massachusetts, southward to Beaufort, North Carolina (Hildebrand, 1963). During some summers, it is fairly common at Woods Hole, while during other summers it is absent. It appears only occasionally off Connecticut, New York, and New Jersey.

In the northern Gulf of Mexico, it has been caught occasionally with bottom trawls. During the winter, it often has been caught with nightlights and lift nets between the 20- and 30-fathom curves.

BUTTERFISH
(Poronotus triacanthus)

Butterfish are now important as food in most areas along the eastern seaboard of the United States. Bigelow and Schroeder (1953) state that this is one of the better table fish. It is also used as a commercial scrap fish in various processed forms, and as a crab bait and fertilizer. It is caught along the northeast coast with pound nets, floating traps, purse seines, and otter trawls. It is not harvested extensively in the Gulf of Mexico, except as an insignificant part of the industrial catch in the northern part (Roithmayr, 1965).

According to Caldwell (1961) and Haedrich (1967), this species ranges from the outer coast of Nova Scotia and Cape Breton, northward as a stray to the Gulf of St. Lawrence, and southward to Cape Kennedy, Florida. It appears to be absent around southern Florida and, in the Gulf, the species ranges from Cape Romano along the coast to the Yucatan Peninsula.

This beautiful silvery fish occurs at the surface, in midwater, or at or near the bottom, but it is classified as a midwater pelagic. Exploratory records and Caldwell's findings indicate that in the Gulf of Mexico butterfish are found in shallower waters more frequently than in the Atlantic. Table 1 shows distribution patterns by season and depth in zones 1 through 7, where no seasonal onshore-offshore movement is shown.

CHUB MACKEREL
(Scomber japonicus)

One of the smaller species of mackerels, it grows to a length of 35 cm, or about 14 inches. Bigelow and Schroeder (1953) agree that its appearance, schooling, and feeding habits are similar to that of the northern mackerel, Scomber scombrus. It occurs in warm and temperate parts of the Atlantic, north to the Gulf of St. Lawrence and south around the tip of Florida, and the Gulf Coast

to at least the Yucatan Peninsula. Chub mackerel have not been reported from south of the Yucatan Peninsula to the Venezuela coast (zones 10 to 12), but its distribution is continuous along the northern part of South America (zones 13 to 16). Before 1951, this species had never been reported south of Virginia, but Rivas (1951) recorded it as S. colias from Garden Key, Florida, and off Cuba, and Simpson and Griffiths (1967) off Venezuela.

The depth distribution of this species in the northern Gulf of Mexico is from about 5 to 200 fathoms (Figure 7). In faunal zone 6, it appears to concentrate between 11 and 30 fathoms; in zone 7, it appears to concentrate between 11 and 50 fathoms.

Chub mackerel are occasionally caught in the Gulf of Maine, but sporadic occurrence in that area probably limits its commercial potential. Bigelow and Schroeder (1953) reported that in this area there have been times of great abundance followed by long periods of scarcity. It is not harvested in other parts of its range, except off Venezuela (Simpson and Griffiths, 1967).

Table 1 - Butterfish catch records of exploratory fishing with trawl by depth and season in faunal zones 1 through 7

Zone/season		Depth (fms.) 1-10	11-20	21-30	31-50	51-100	101-200	201 +
1	Jan.-Mar.	-	1	4	5	4	-	-
	April-June	-	2	-	5	4	-	-
	July-Sept.	-	-	-	-	3	2	-
	Oct.-Dec.	-	-	-	-	-	-	-
2	Jan.-Mar.	32	13	-	5	6	6	-
	April-June	9	3	1	6	3	1	-
	July-Sept.	31	-	3	-	2	2	-
	Oct.-Dec.	-	-	-	-	-	-	-
3	Jan.-Mar.	14	12	9	14	14	14	3
	April-June	-	-	12	9	7	31	3
	July-Sept.	4	9	2	5	5	10	2
	Oct.-Dec.	10	4	2	4	10	13	2
4	Jan.-Mar.	22	11	27	28	8	2	-
	April-June	-	1	7	6	-	-	-
	July-Sept.	15	1	3	6	-	-	-
	Oct.-Dec.	14	-	2	3	-	-	-
5	Jan.-Mar.	1	2	8	2	1	-	-
	April-June	-	3	-	-	-	-	-
	July-Sept.	-	-	1	2	-	-	-
	Oct.-Dec.	-	-	-	-	-	-	-
6	Jan.-Mar.	41	43	53	35	6	1	-
	April-June	15	5	3	7	3	6	-
	July-Sept.	6	23	22	10	3	4	3
	Oct.-Dec.	21	14	7	11	3	-	-
7	Jan.-Mar.	8	8	11	45	5	1	-
	April-June	10	11	9	2	2	-	-
	July-Sept.	49	44	23	75	10	-	-
	Oct.-Dec.	1	-	2	4	1	-	-

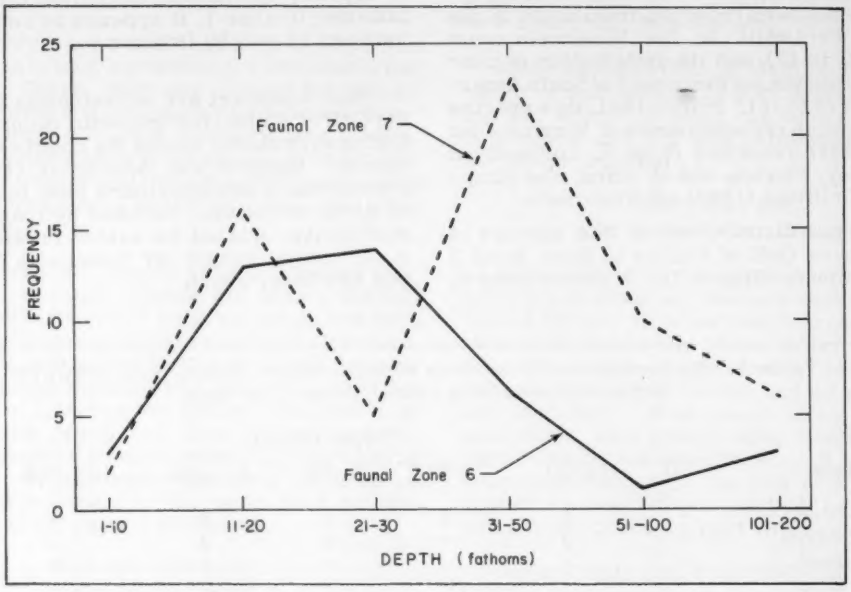

Fig. 7 - Depth distribution of chub mackerel in faunal zones 6 and 7.

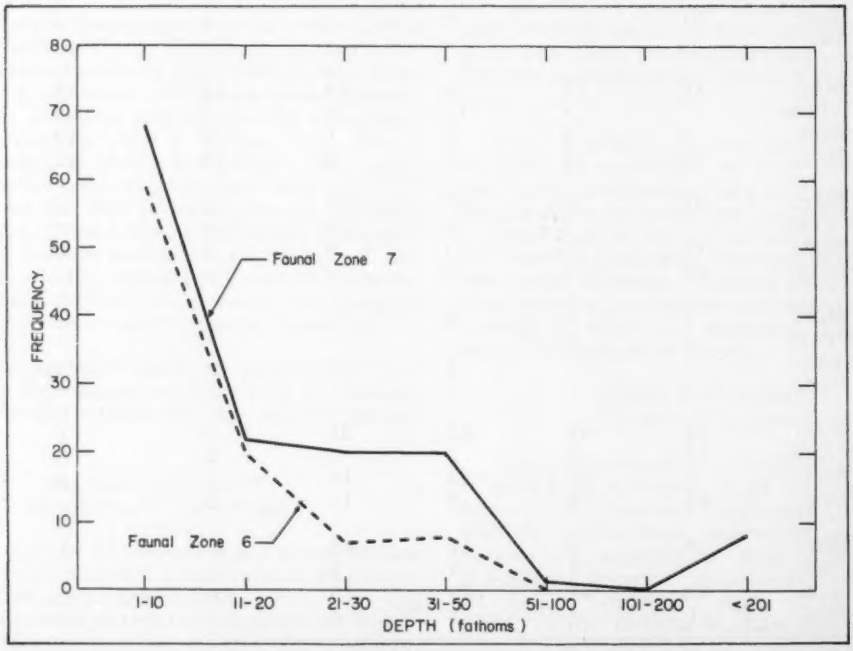

Fig. 8 - Depth distribution of bumpers in faunal zones 6 and 7.

BUMPER
(Chloroscombrus chrysurus)

This very common fish occurs from Cape Cod southward throughout the Gulf of Mexico. Bumpers are also found in the Caribbean Sea to Brazil (Ginsburg, 1952). It is commonly caught with beach seines in northwest Florida, and with shrimp trawls throughout most of the Gulf of Mexico. Although most commonly found within 10 fathoms, it occurs offshore to at least the 1,000-fathom curve in the northern Gulf, and out to the 500-fathom curve off northeast Florida. Throughout the rest of its range, it is rarely found beyond the 50-fathom isobath (Figure 8).

ROUGH SCAD
(Trachurus lathami)

It is known from nearly all warm and temperate seas, and along our Atlantic coast from Cape Cod southward to Brazil. The rough scad is rare in the northern part of its range, but it is fairly common off the Florida Keys and in the northern Gulf of Mexico east of the Mississippi Delta.

It is generally found slightly farther offshore than other coastal pelagic species, most commonly between the 30- and 50-fathom contours (Figure 9).

ROUND SCAD
(Decapterus punctatus)

This fish is usually found in small schools along the Atlantic seaboard from Nova Scotia to Brazil, including the Gulf of Mexico, the West Indies, and Bermuda. Berry (1968) indicates that its distribution is continuous. Juveniles are pelagic and may prefer oceanic rather than coastal waters, but they do occur around oceanic islands. Throughout its range, it can be found from the shore out to the Continental Slope.

In faunal zones 6 and 7, in the northern Gulf of Mexico, its seasonal depth distribution is shown in Table 2 and Figure 10. During the winter, it is found mostly beyond the 20-fathom curve to 50 fathoms. In the spring, however, it is concentrated within the 10-fathom curve. In the summer, it appears to move farther offshore and concentrate, at least in faunal zone 6, between the 11- and 20-fathom contours. During the fall, it again moves inshore close to the beach, but it is more or less uniformly distributed from the shore line out to about the 100-fathom contour.

Caught For Bait

Rough scad are caught for bait with beach seines along the Florida panhandle from April to November. Since 1960, production and value have increased because of the increase in demand for bait fish (as mentioned with Spanish sardine). In 1967, more than $\frac{1}{2}$ million pounds worth slightly more than $65,000 were landed (Figure 11). More than 60 percent of the annual yield is produced in June and July.

During the summer, this species schools off northwest Florida with the Spanish sardine and, to some extent, with the scaled sardine. Klima and Wickham (1971) have observed dense schools of mixed round scad and rainbow runner, Elagatis bipinnulatus, around submerged structures.

THREAD HERRING
(Opisthonema oglinum)

This tropical and subtropical fish occurs intermittently along the eastern seaboard from Cape Cod to southern Brazil. It is usually found from 4 to 50 fathoms. In the northeastern Gulf of Mexico, it is most commonly found within the 20-fathom curve (Figure 12). Bullis and Thompson (1967) estimate the density of thread herring in this area to be one school per square mile. Observations in the northern Gulf indicate that thread herring stocks are not as numerous there as off Florida's west coast.

Commercial interest in the thread herring stocks was stimulated by an off-season aerial survey for menhaden conducted by the Bureau of Commercial Fisheries during the winters of 1963-64, 1964-65, and 1965-66 (Thompson, 1968). During 15 monthly flights, 5 each winter season, over traditional menhaden grounds along the west coast of Florida, almost 1,800 schools were observed. Almost 900 schools of thread herring were observed south of 29° N latitude during these flights. Other schools were comprised of scaled sardine, Spanish sardine, and yellowfin menhaden. Species identification of the schools was made from coordinated gill-net samplings.

Possibly Million Tons

Based on average catch rates of commercial sets, an extrapolation indicates a possible thread herring stock of about one million tons (Bullis and Thompson, 1967). During the Bureau's exploratory fishing, thread herring

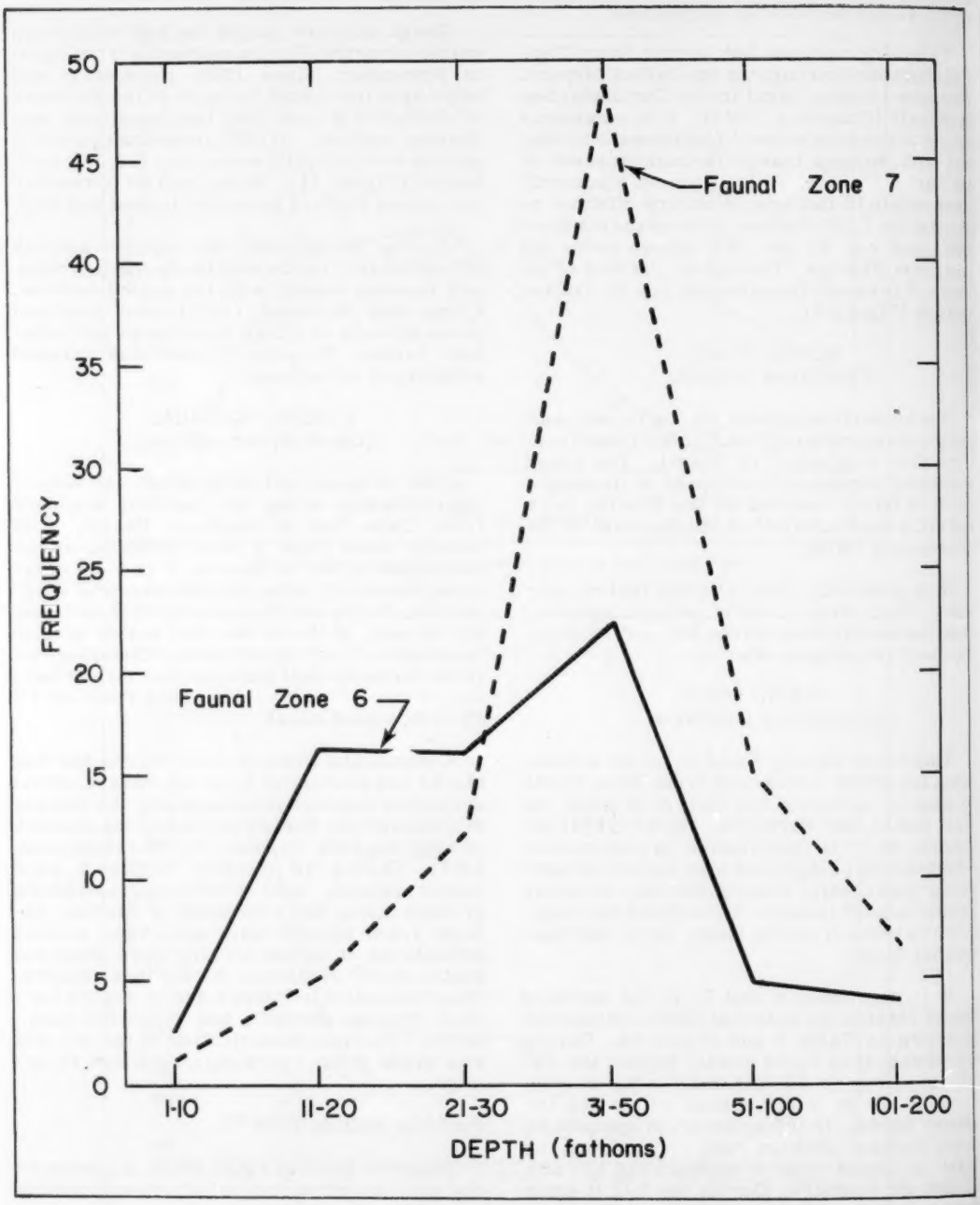

Fig. 9 - Depth distribution of rough scad in faunal zones 6 and 7.

Table 2 - Round scad catch records of exploratory fishing with trawl by depths and season in faunal zones 6 and 7

Zones	Depth (fms.) 1-10	11-20	21-30	31-50	51-100	101-200	200 +	Total
6								
Jan.-Mar.	2	25	32	34	6	1	-	100
April-June	11	4	1	1	2	1	-	20
July-Sept.	1	19	12	5	1	-	-	38
Oct.-Dec.	10	16	8	11	6	-	-	51
7								
Jan.-Mar.	-	4	4	27	2	-	-	37
April-June	3	5	5	3	1	-	-	17
July-Sept.	1	25	13	57	12	-	-	108
Oct.-Dec.	13	12	11	13	-	-	-	49

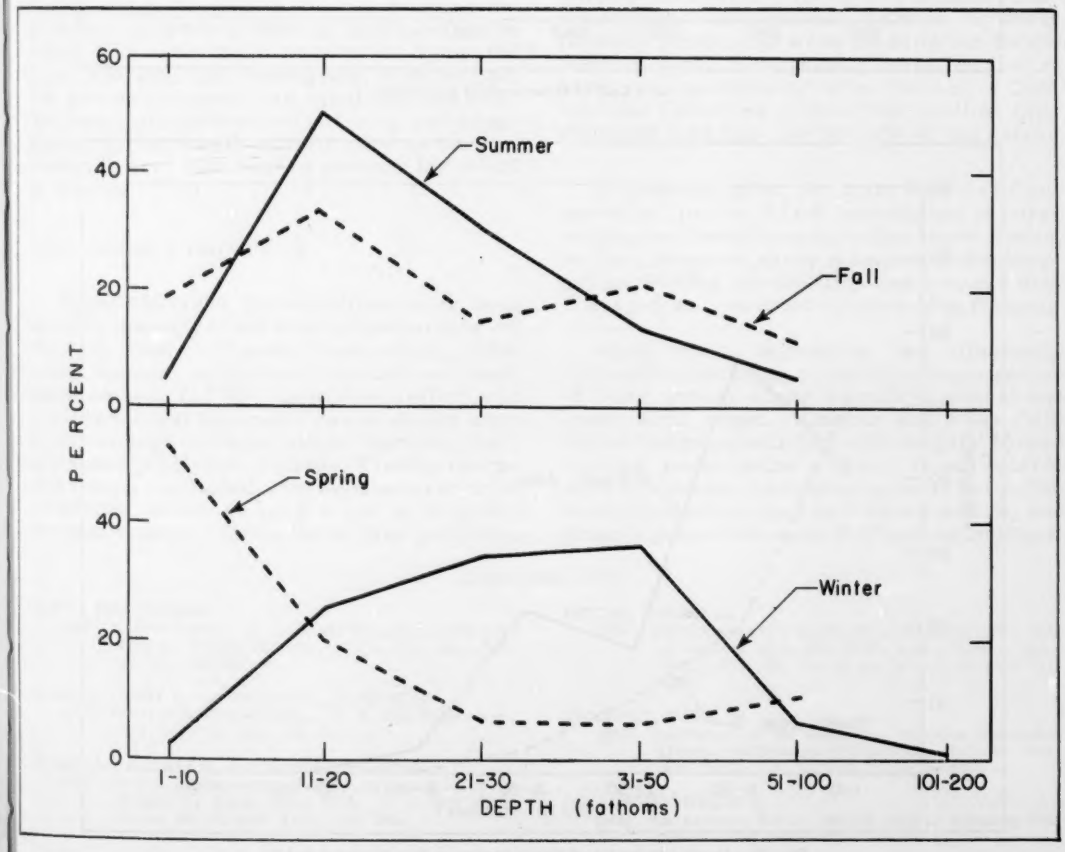

Fig. 10 - Depth distribution of round scad by season in faunal zone 6.

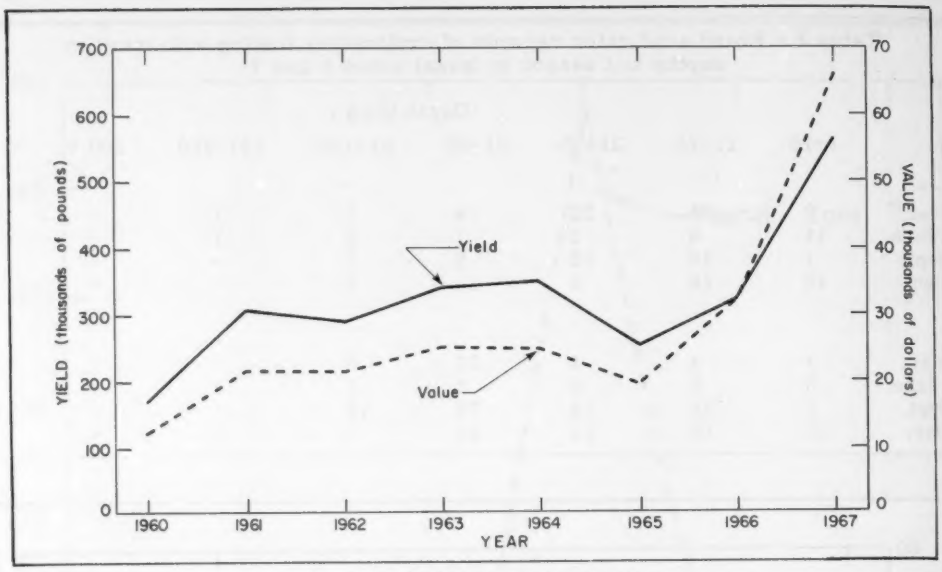

Fig. 11 - Gulf of Mexico round scad catch.

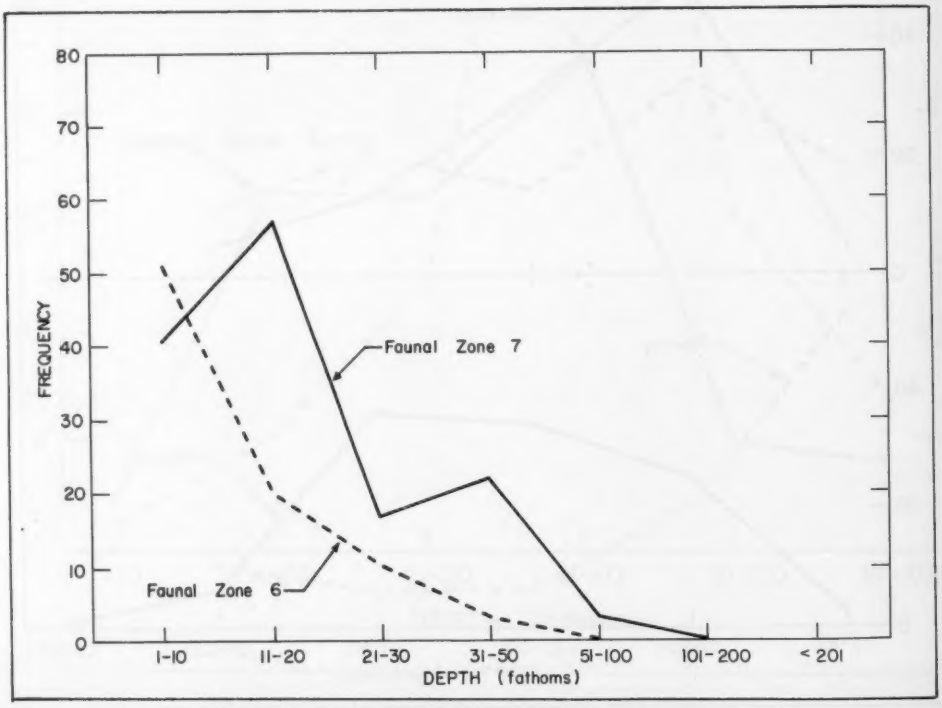

Fig. 12 - Depth distribution of thread herring in faunal zones 6 and 7.

were caught in all areas of the Atlantic south of Cape Hatteras, and throughout the entire Gulf of Mexico. Catches occurred throughout every season from the Mississippi Delta to the east coast of Florida, and off Louisiana and Texas in every month except June, July, and December. Thread herring are most numerous in the summer and fall in the latter area.

Thread herring has perhaps the best immediate commercial potential because moderate amounts already have been harvested along Atlantic coast, off Fernandina Beach, Florida, and off Fort Myers in the Gulf by menhaden fishermen. Accurate catch statistics are not available since small catches and/or catches mixed with menhaden are usually recorded as menhaden (Butler, 1961).

In addition to gear problems, perhaps the greatest were the problems of disposing the catch. The fish were transported to Apalachicola, Florida, and Pascagoula, Mississippi, for processing into fish meal and pet food. The long distance between catching and processing areas added significantly to the raw material cost and caused serious logistical problems.

Some Industry Harvesting

Since 1958-1959, limited efforts have been made by industry to harvest thread herring off the west coast of Florida (Fuss, et al., 1969) using lampara seines and one-and two-boat purse seines. In 1967, a significant effort was made to harvest the west Florida stocks when a processing plant was built at Charlotte Harbor near Fort Myers, Florida. Fishing operations were conducted with standard two-boat menhaden purse seiners and a modified shrimp vessel. There were gear problems and fishing was limited to small, smooth-bottom areas close inshore from Gasparilla to Sanibel Islands.

In 1967 and 1968, the vessels of three different companies produced about 15,000 tons of thread herring. The limited-capacity plant at Charlotte Harbor handled a good part, and plants at Dulac, Louisiana, and Apalachicola, Florida, also processed part. Catches were transported to the two distant plants in large (up to 500-ton capacity) refrigerated menhaden vessels.

Legal Restrictions & Weather

Legal restrictions and weather also limited production in the area during 1967 and 1968. Florida laws prohibit catching of foodfish by purse seines within Florida's 10.5 mile jurisdiction, and insignificant catches of these (usually predators) were made in the thread herring sets. This greatly curtailed fishing until catch monitoring by the Bureau of Commercial Fisheries showed that foodfish represented less than one percent of the catch.

In February 1968, the State Board of Conservation permitted resumption of purse seining for thread herring within those limits. By then, however, those vessels with the largest harvesting capabilities had become discouraged and returned to menhaden fishing.

Also, recent legislation has effectively closed this fishery by prohibiting purse seines in state waters along Florida's central and lower Gulf coast. Kinnear and Fuss (MS) stated that prospects for continuing the thread herring purse-seine fishery from outside state waters are discouraging because the fish do not appear to school in offshore waters, and present gear is not capable of harvesting them.

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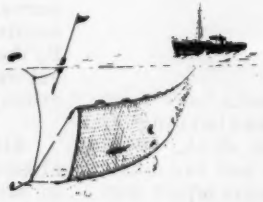

THE ATLANTIC SURF CLAM FISHERY - 1969

Allan M. Barker and John W. Ropes

The 1969 surf-clam fishery produced record landings of 49.6 million pounds of meats--9.7 million pounds more than in 1968. The New Jersey catch of 38.8 million pounds, an increase of 7.0 million pounds, almost equaled the total landings for 1968. Maryland and New York landings increased by 7.1 and 3.7 million pounds, respectively. The fleet size expanded and the southward shift continued. The number of vessels decreased at Point Pleasant, N.J., but increased at Cape May-Wildwood, N.J., and at Ocean City, Md.

FISHING AREAS

Cape May-Wildwood, N.J., and Point Pleasant, N.J., were the major surf-clam fishing areas in the middle Atlantic bight in 1969; Ocean City, Md., and Long Island, N.Y., provided the remainder of the catch. The New Jersey fishery continued to contribute most of the total landings, although the 38.8 million pounds landed were a smaller percentage (78%) than in 1968 (Table). Landings from the Cape May-Wildwood area were almost twice those from Point Pleasant.

SURF CLAM LANDINGS BY AREAS (1969)

Area	Number of Vessels		Landings (Millions of lbs.)	
	1968	1969	1968	1969
Cape May-Wildwood, N.J.	42	43	18.0	24.8
Point Pleasant, N. J.	30	28	13.8	14.0
Ocean City, Md.	7	14	5.2	7.1
Long Island, N.Y.	7	7	2.9	3.7
Total	86	92	39.9	49.6

The areas fished by New Jersey boats in 1969 (Fig. 1) were similar to 1968 (Yancey, 1970) but more trips were made to the southern areas. The Ocean City, Md., vessels worked mostly inshore and north of the Ocean City inlet, as in 1968. The Long Island, N.Y., surf-clam landings were taken off Long Beach and Fire Island.

FLEETS AND METHODS

The New York fleet remained at 7 vessels (as in 1968) until late in the year, when one moved to New Jersey. The fleet, based at Freeport, L.I., consisted of 5 full-time and 2 part-time vessels; the latter landed clams for fish bait. Average catch per trip for the full-time vessels was 182 bushels (3,000 pounds of meats). Total landings of 3.5 million pounds of meats for food and 0.2 million pounds for bait resulted from average monthly landings of 180,000 to 575,000 pounds of meats.

The Point Pleasant fleet decreased for the third consecutive year--the 28 vessels were 2 less than 1968. Boats operating out of Atlantic City were included in the 1969 total because they fished the same beds as the Point Pleasant fleet. Depths fished ranged from 12 to 37 meters (40 to 120 feet); average depth was 23 meters (76 feet). Most vessels made 1-day trips, but some overnight trips were made to more distant grounds. Hours fished per boat-day ranged from 3 to 22. Monthly averages are shown in Figure 3. The average for 1969 was 9.5 hours, a decrease of 0.3 hour from 1968.

The Cape May-Wildwood fleet increased to 43, one more than 1968. Two large stern-dredgers started operating in 1969. Depths fished ranged from 7 to 35 meters (22 to 114 feet); average depth was 14 meters (46 feet).

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COMMERCIAL FISHERIES REVIEW
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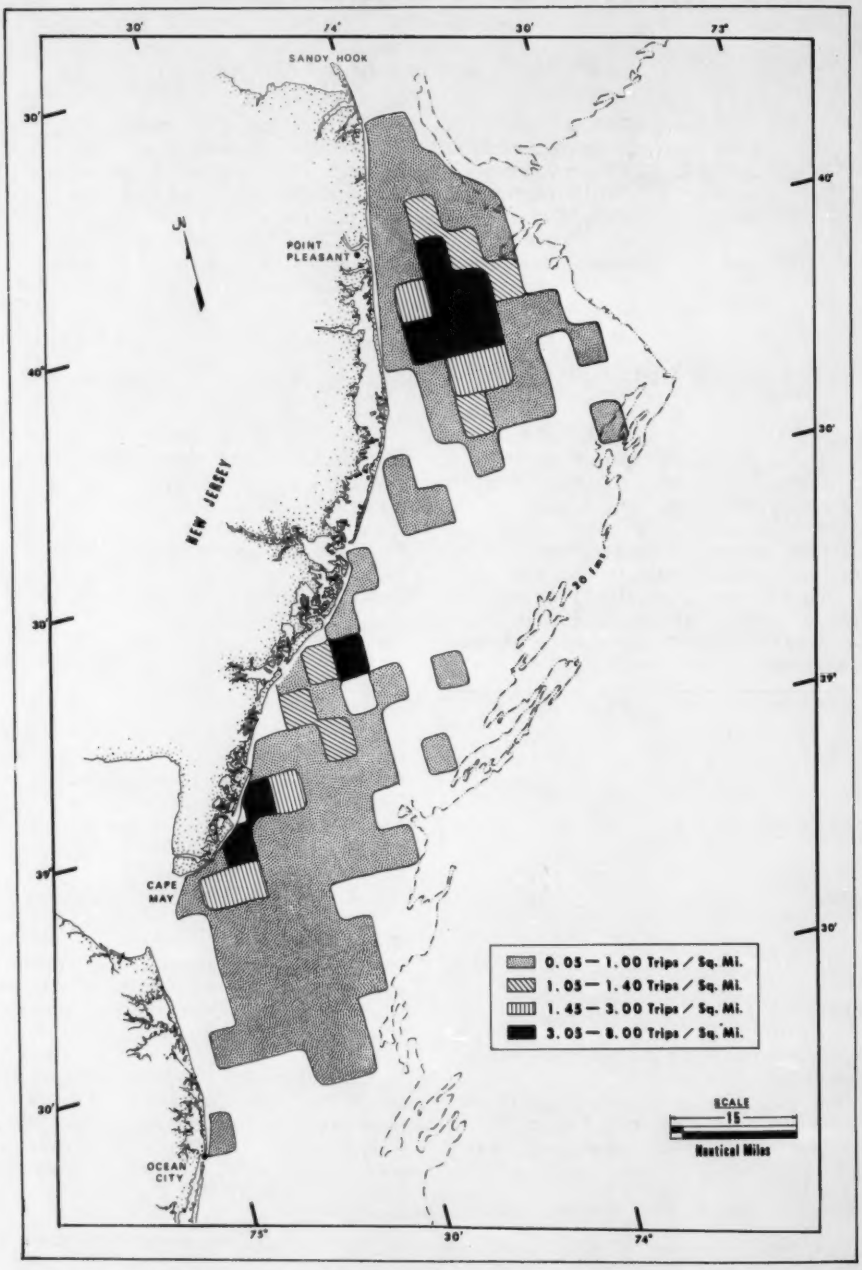

Fig. 1 - Area and intensity of surf-clam fishing by New Jersey fleet, 1969 (based on 1,955 interviews).

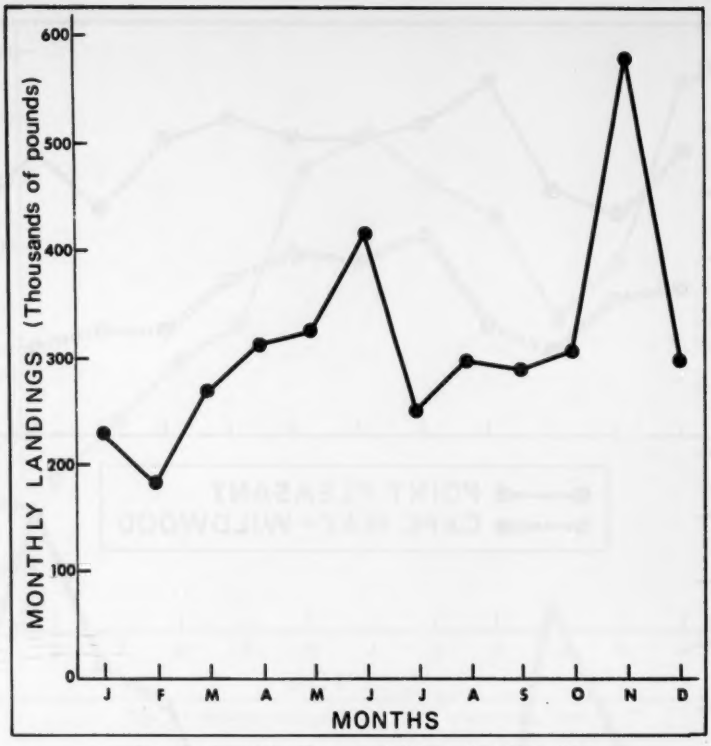

Fig. 2 - Monthly landings of surf clams in New York, 1969.

Most vessels made 1-day trips and worked during daylight hours. Monthly averages of hours fished per boat-day are shown in Figure 3. Daily effort ranged from 2 to 20 hours. The average for 1969 was 7.2 hours, a decrease of 0.7 hour from 1968. During the last half of 1969, 2 to 4 boats landed clams at Lewes, Del., the first landings there since 1962. These values were included with those for Cape May-Wildwood because 2 of the vessels were based at Wildwood and all of the clams came from the areas fished by the Cape May-Wildwood fleet.

The Ocean City fleet expanded to 14 vessels, an increase of 7 from 1968. Landings of 7.1 million pounds of meats in 1969 were the direct result of additional vessels using the port (Fig. 4). No interview data were available to determine catch and effort by boat.

NEW JERSEY LANDING STATISTICS

Interviews by a port sampler provided information on fishing areas and effort in New Jersey. Landings in the middle Atlantic bight were supplied by the NMFS Division of Statistics and Market News.

Record landings of 49.6 million pounds of meats were 9.7 million pounds higher than in 1968 (Table). Most of the increase was due to the greater poundage (6.8 million pounds) landed by the Cape May-Wildwood fleet. New Jersey produced 38.8 million pounds--7.0 million pounds more than in 1968. Maryland and New York landings also increased (1.9 and 0.8 million pounds). New Jersey landings were 78% of the 1969 total; Maryland, 14%; and New York, 8%. Contributions by the respective states in 1968 were 80%, 13%, and 7%. Less than 2% of the total catch was used for bait.

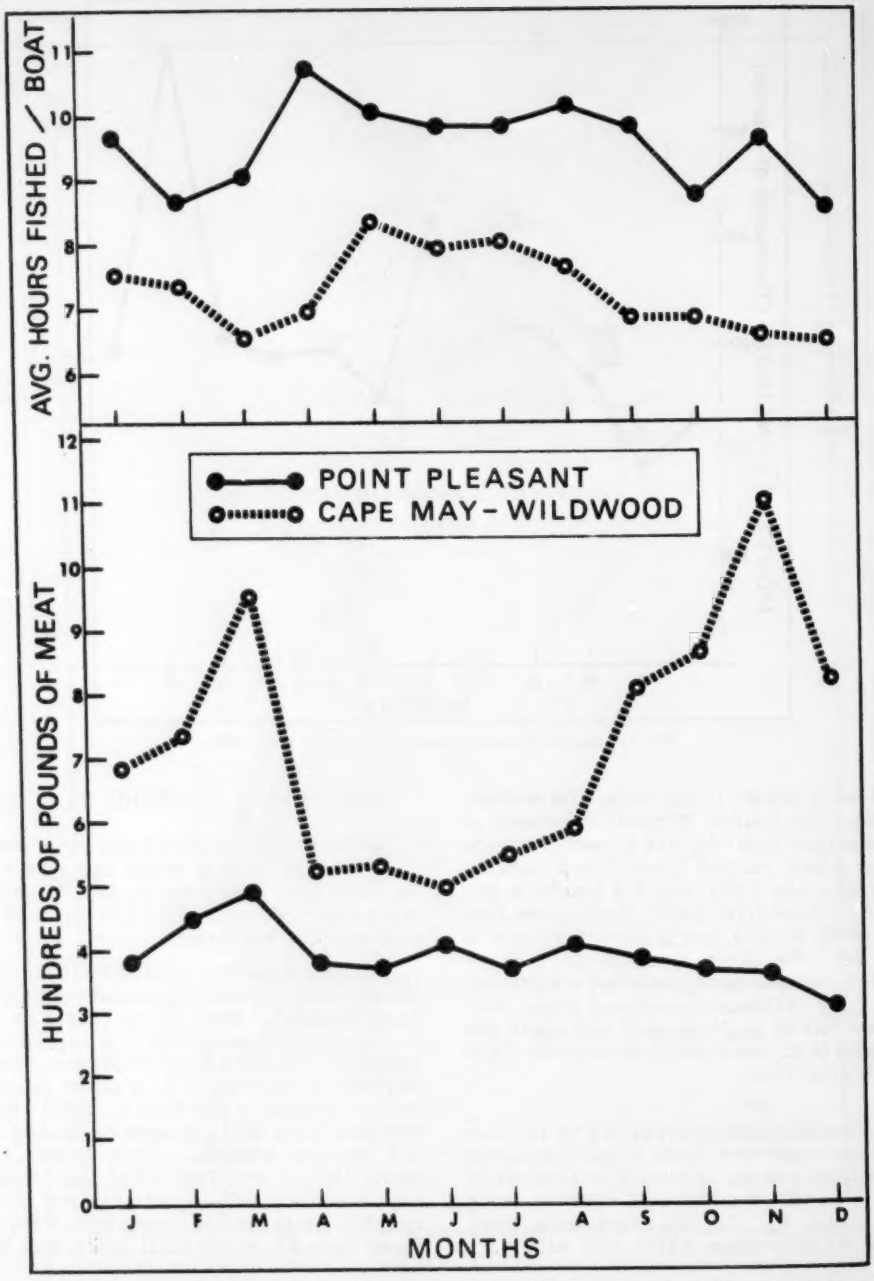

Fig. 3 - Monthly averages of daily effort (upper) and catch per hour (lower) at Point Pleasant and Cape May - Wildwood, N. J., 1969.

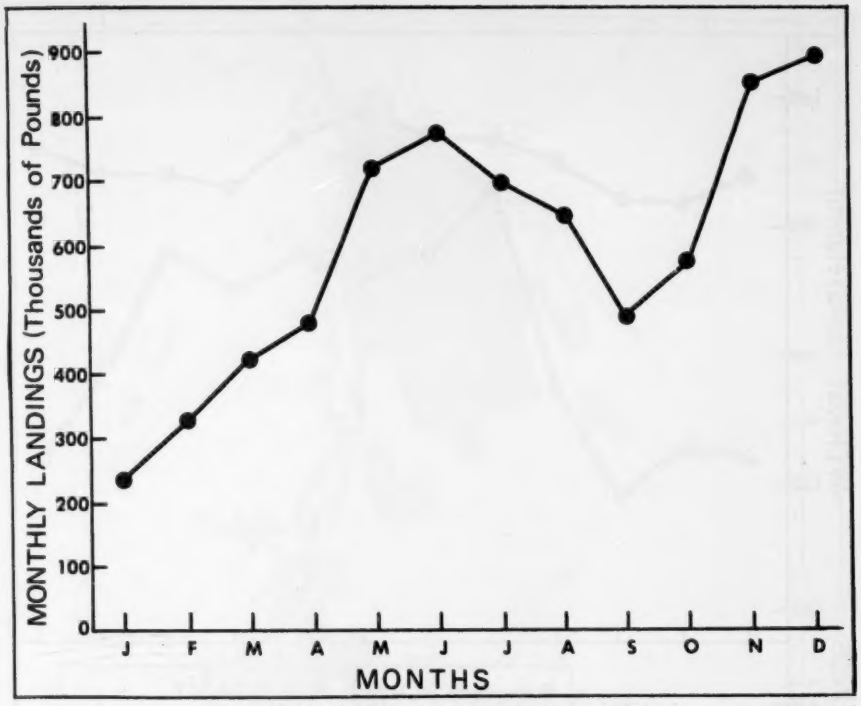

Fig. 4 - Monthly landings of surf clams in Maryland, 1969.

Cape May-Wildwood Fleet

Contributions to the total New Jersey landings by the Cape May-Wildwood fleet have increased markedly during the past 5 years. The number of vessels at Cape May-Wildwood and Point Pleasant was about the same as in 1968, but Cape May-Wildwood provided 62% (24.8 million pounds) in 1969--up from 57% in 1968. Much of the increase was due to the operation of 2 large stern-dredge vessels based at Wildwood.

At Cape May-Wildwood, landings per boat-day ranged from 43 to 1,400 bushels (731 to 23,800 pounds of meats) and averaged 289 bushels (4,913 pounds). The average in 1968 was 225 bushels (3,825 pounds). Monthly landings varied little except in March, when a dense bed of small inshore clams off Atlantic City was heavily fished (Fig. 5). Catch per hour increased from 28 bushels (476 pounds) in 1968 to 43 (731 pounds) in 1969. Figure 6 shows the catch per hour in the areas fished. The catch rate dropped sharply in May when the fleet moved offshore to fish for large (150 mm) clams (Fig. 5). About two-thirds of all trips made in 1969 were to inshore areas. The average catch rate for inshore and offshore clams was 48 bushels (876 pounds) and 26 bushels (442 pounds) respectively. Monthly average lengths reflected the seasonal shift in effort from inshore to offshore beds (Fig. 5). Lengths of clams landed ranged from 109 to 187 mm (4.3 to 7.4 inches). The average length of inshore clams was 131 mm (5.3 inches); offshore clams average 155 mm (6.2 inches) long; and the average for all clams measured was 137 mm (5.4 inches) or 10 mm (0.4 inch) less than 1968.

Point Pleasant

The Point Pleasant share of the New Jersey landings decreased from 43% in 1968 to 36% in 1969. Most of the decrease was due to the higher landings at Cape May-Wildwood (36% larger than 1968). Landings at Point Pleasant per day-trip ranged from 32 to 600 bushels (544 to 10,200 pounds of meats) and averaged 221 bushels (3,757 pounds). The average in 1968 was 233 bushels (3,961 pounds). Catch

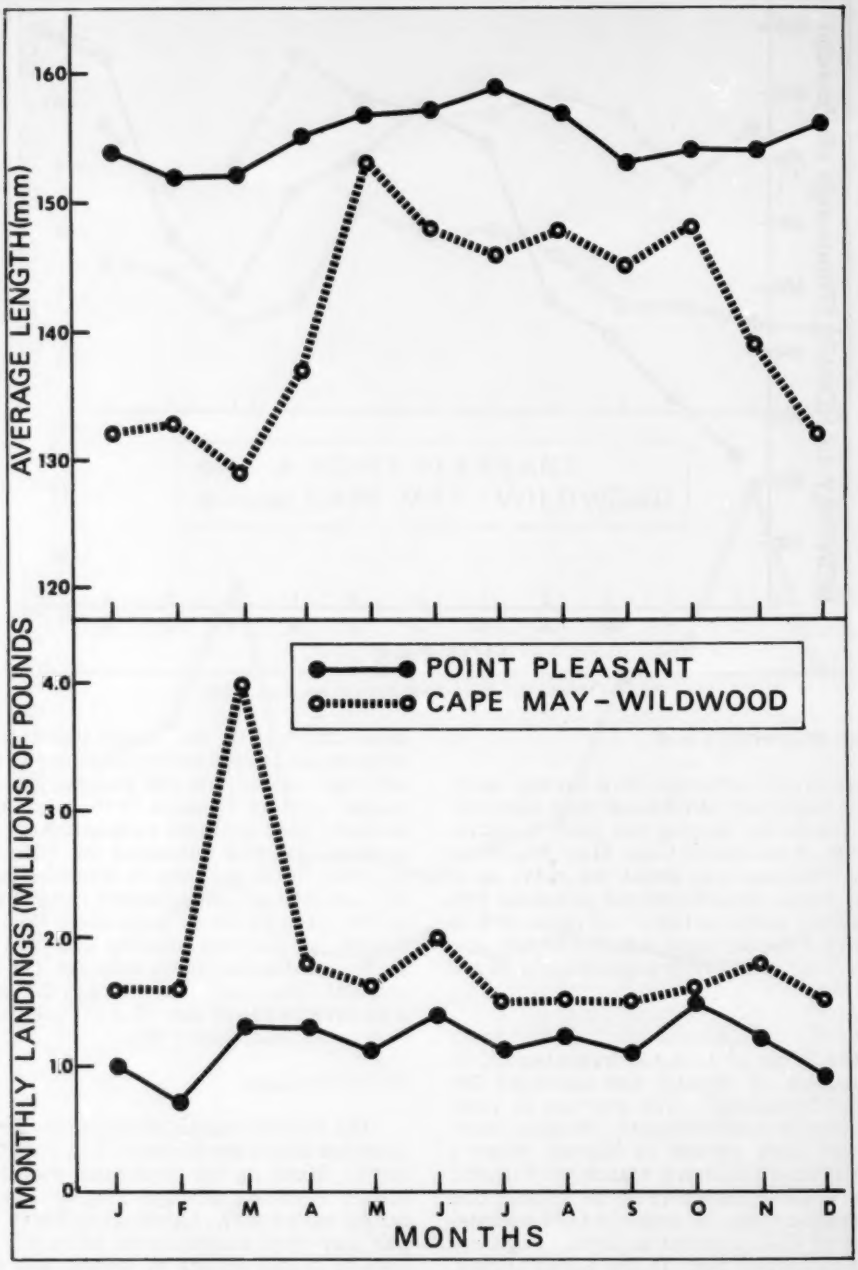

Fig. 5 - Monthly mean lengths of surf clams (upper) and landings (lower) in New Jersey, 1969.

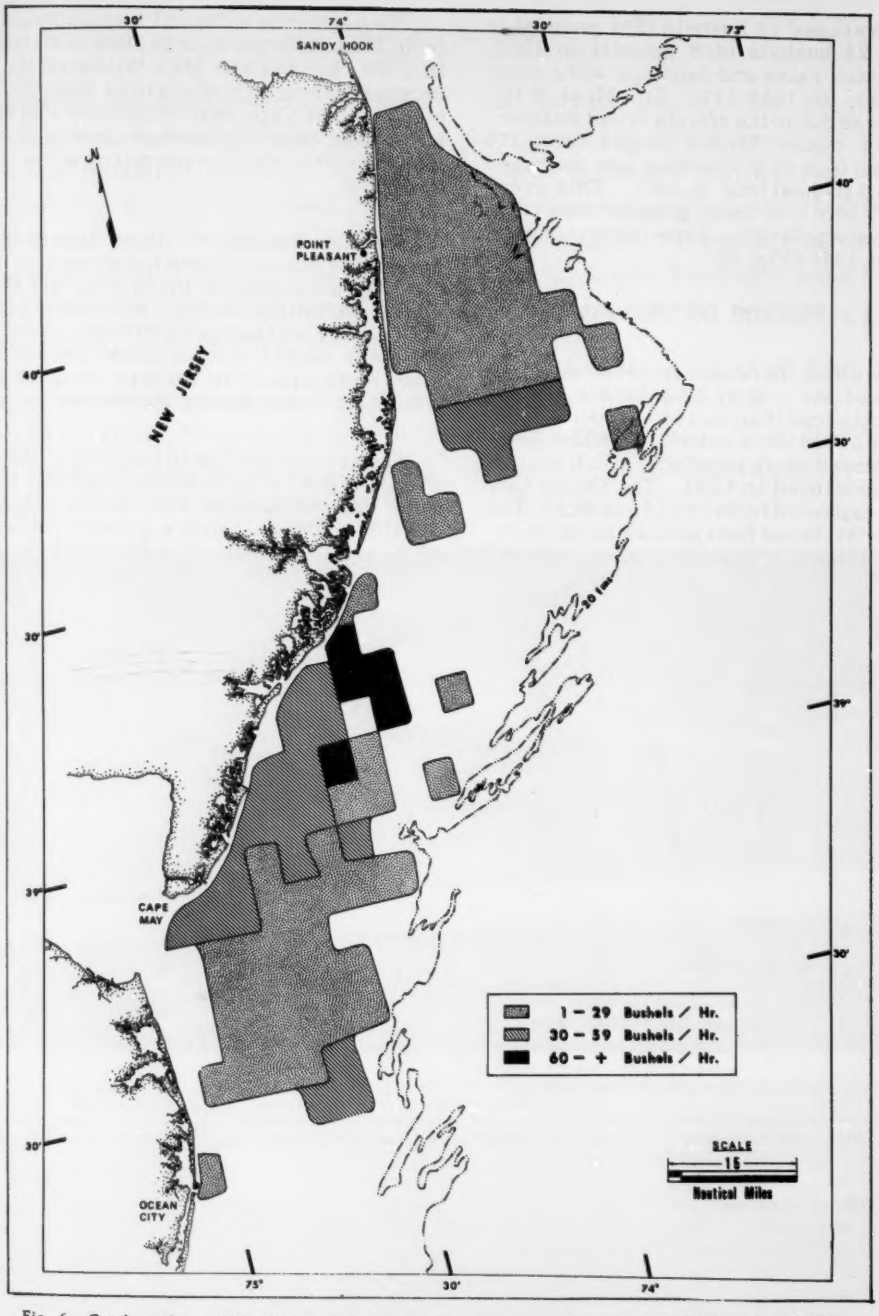

Fig. 6 - Catch per hour within the area fished by the New Jersey surf-clam fleet in 1969 (based on 1,955 interviews).

per hour averaged 23 bushels (391 pounds) in 1969 and 24 bushels (408 pounds) in 1968. Monthly catch rates and landings were relatively stable in 1969 (Fig. 5). Most of the variation was due to the effects of bad weather. Lengths of clams landed ranged from 116 to 203 mm (4.6 to 8.0 inches) and averaged 155 mm (6.2 inches) long in 1969. This average was 2 mm (0.1 inch) greater than 1968. Monthly average lengths were fairly constant throughout 1969 (Fig. 5).

STATUS & TRENDS OF THE FISHERY

Fishing effort increased in 1969. Although hours fished per trip by New Jersey vessels were slightly less than in 1968, about 6 more boats were added to the entire surf-clam fleet. The southward shift in effort, which started in 1967, continued in 1969. The Ocean City, Md., fleet expanded from 7 to 14 vessels. The Cape May-Wildwood fleet added 2 large stern-dredgers. The New York fleet remained at 7 vessels.

The catch rate at Point Pleasant decreased from 24 bushels per hour in 1968 to 23 bushels in 1969, but at Cape May-Wildwood the rate increased from 28 bushels to 43 bushels. The high rate at Cape May-Wildwood was due to an intense effort by the fleet on beds of small inshore clams and the operations of the stern-dredgers.

Average lengths of clams landed in New Jersey in 1969 were about the same as in 1968. Monthly averages at Point Pleasant showed minor variations during 1969; those at Cape May-Wildwood fluctuated with season because the fleet moved from offshore beds of large (150 mm) clams to inshore beds of small (120 mm) clams during the winter.

The gradual decline in landings at the Point Pleasant port will probably continue, but the Cape May-Wildwood and Ocean City fleets should expand and catch a greater percentage of the total landings. The New York fleet will probably stabilize at its present size.

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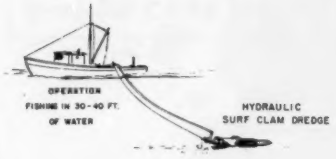

TRAPPING SABLEFISH

William L. High

Fish traps have been an effective capturing gear used by both sophisticated and primitive cultures for thousands of years. Recently, the concept has enjoyed a renewed interest because of improved construction techniques and the prime quality of fish captured--and because traps are often species-specific, thereby reducing waste of unwanted fish.

During the past three years, the NMFS Seattle Exploratory Fishing and Gear Research Base has carried out experimental fishing for sablefish (Anaplopoma fimbria) with various trap designs. A collapsible steel-mesh trap is now used by the R/V 'John N. Cobb' to estimate sablefish populations and their distribution along the Washington and Oregon coasts. The commercial fishing vessel M/V 'Seattle' has fished traps for sablefish intermittently for two years.

The fish-catch rates of traps may vary widely depending upon time of year and depths fished. The Seattle's most successful trip produced 50,000 pounds with 1,077 trap liftings in 14 days.

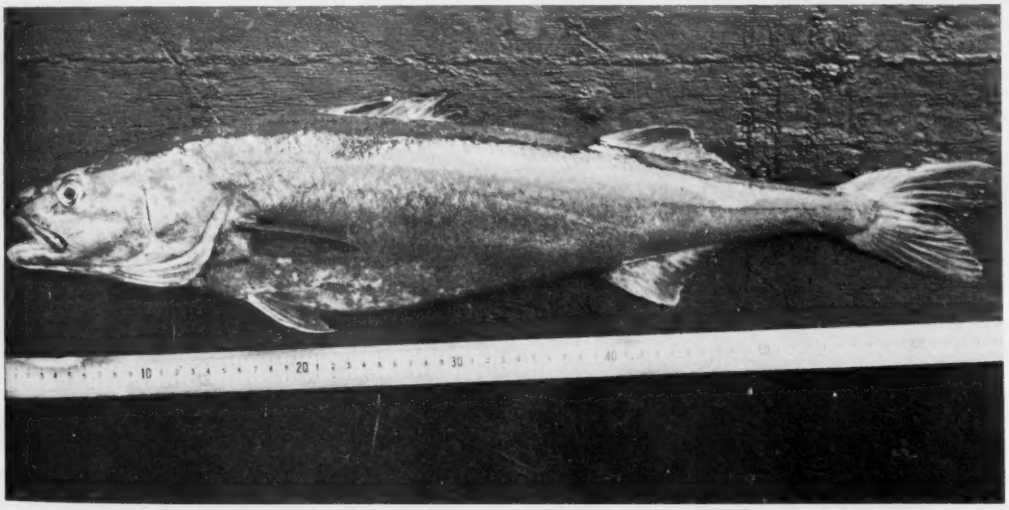

Fig. 1 - Sablefish (Anaplopoma fimbria), commonly called blackcod by west coast fishermen, are captured in deep water from California to Alaska. The fish has excellent flesh quality and is primarily kippered.

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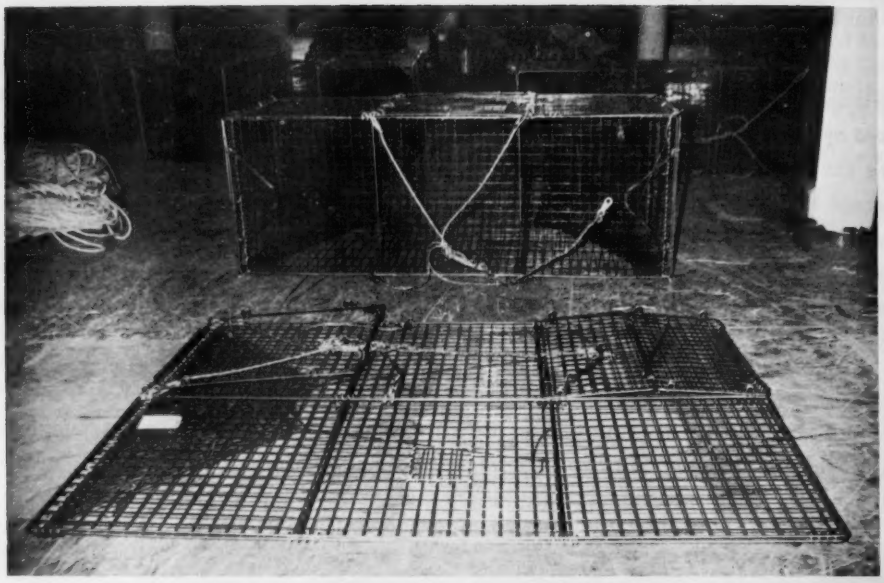


Fig. 2 - The collapsible trap currently used by NMFS is 34 inches by 34 inches by 8 feet long. Steel mesh is 2 inches square to allow small fish to escape. The trap will collapse flat for storage aboard a vessel. All trap parts remain connected, so one fisherman can reassemble a trap in less than one minute.

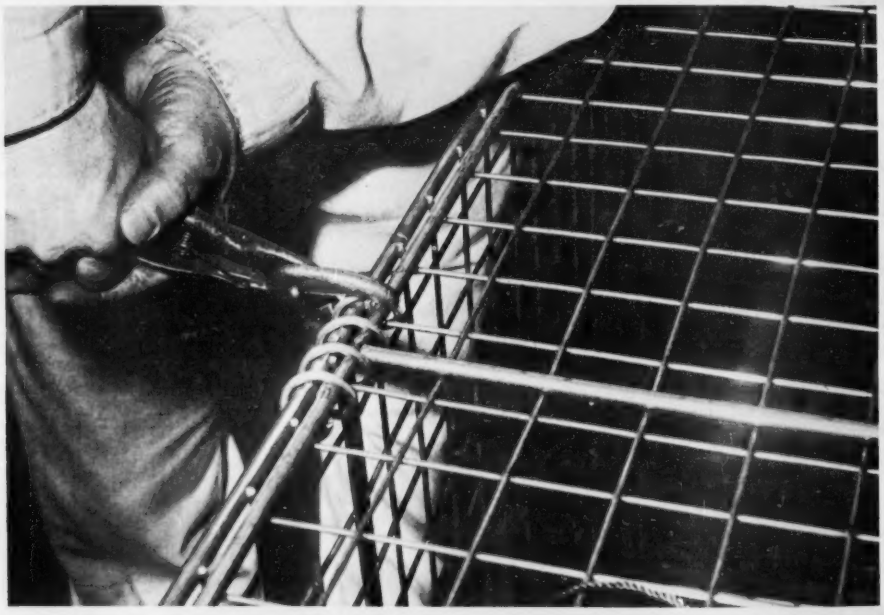


Fig. 3 - Trap side and end pieces are constructed individually, then joined by coiled springs. After each coil is spun into place by hand, the ends are crimped to prevent further movement. The coil also serves as a hinge when the trap is collapsed.

Fig. 4 - A spring-loaded snap hook at the end of the bridle permits the trap to be quickly connected or released from the groundline. Small rope loops (beckets) are placed at intervals (commonly 50 fathoms) in the groundline to space traps evenly.

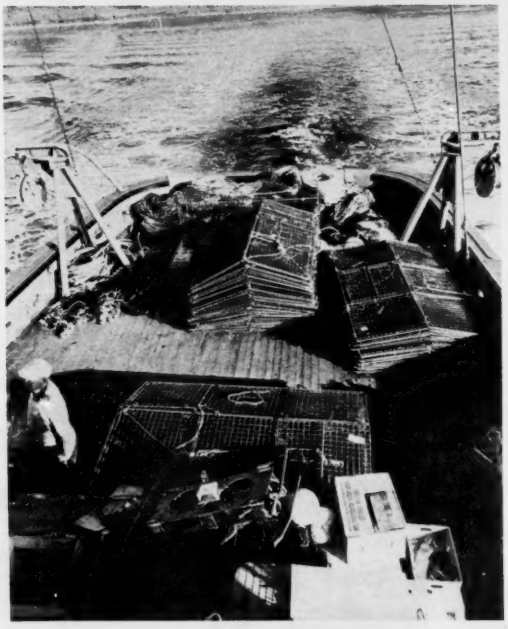


Fig. 5 - Forty-five ready-to-assemble sablefish traps are shown on the after deck of the R/V John N. Cobb. When appropriately stacked for commercial fishing, a smaller vessel could carry 100 to 200 collapsed traps. Once assembled, traps are not collapsed unless the vessel moves to a distant fishing area. Trap strings are usually left to fish whenever the vessel returns to port to unload the iced catch.

Fig. 6 - Chopped frozen herring is placed in a plastic jar for each trap. Hundreds of small holes in the jar and lid permit oils and juices to escape--but prevent the bait from being devoured by sand fleas (anphipods). Bait handling is expedited by placing the jar into the trap loose rather rhan tying, as is done in other trap fisheries. It is done this way because studies suggest there is no increased catch for tied-up bait containers, and the used jar will fall out of the trap as fish are removed.

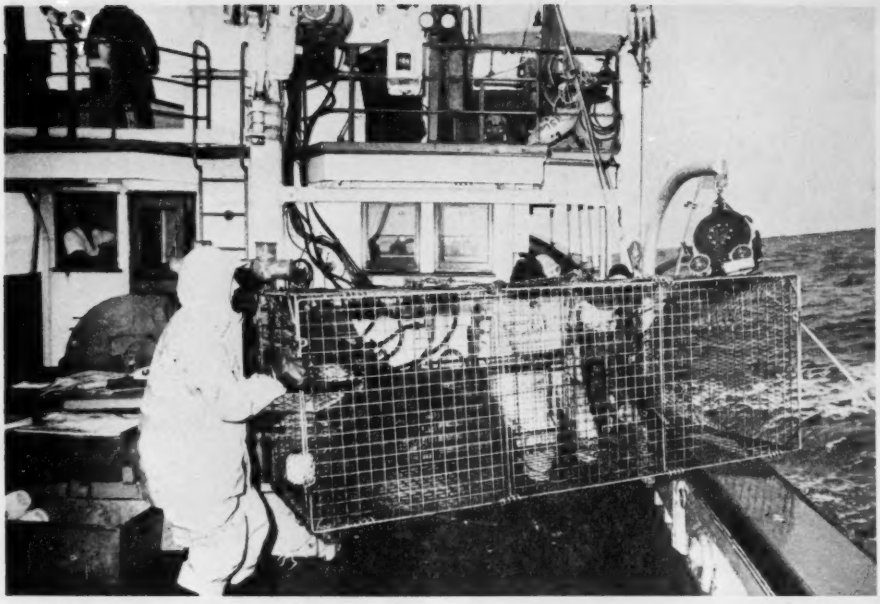


Fig. 7 - Traps are set at intervals along the groundline as it pays out through the hydraulic line hauler. Setting groundline under some tension tends to stretch the line along the ocean floor.

Fig. 8 - During experimental fishing, groundlines up to 600 fathoms long are coiled into a large wooden barrel (tierce) to facilitate handling the single line in rough seas.

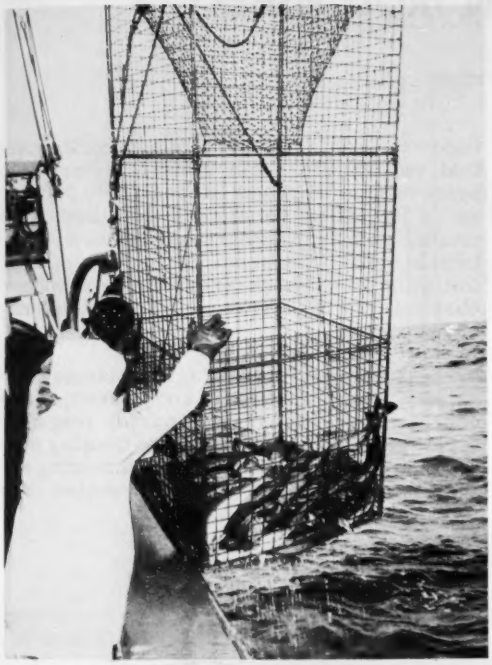


Fig. 9 - Upon surfacing, each trap is unclipped from the groundline and lifted aboard with the ship's hoist. Note the unique, ungated, tunnel orifice.

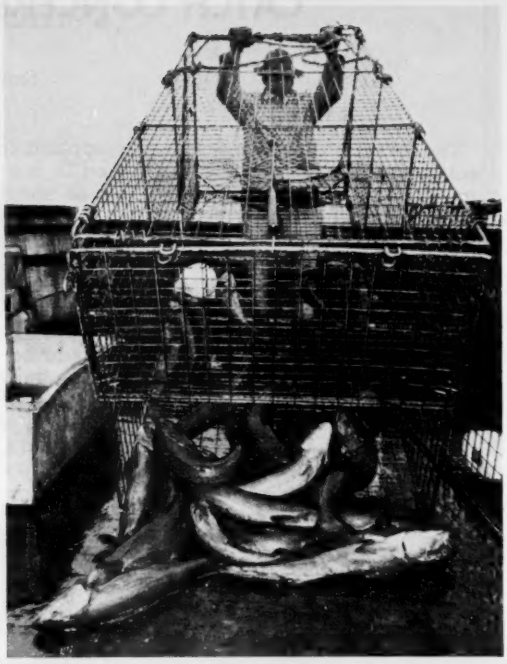
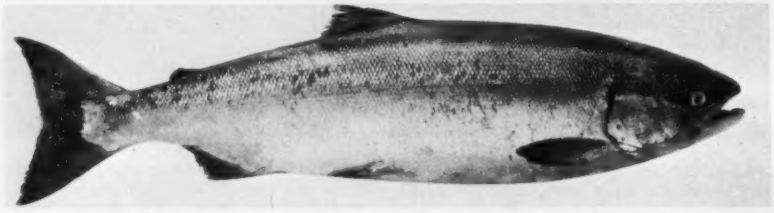


Fig. 10 - The hinged trap end piece is raised to dump both fish and the bait container. Before resetting, a fresh bait jar is placed in the trap.

COHO SHAKER PROBLEM & INCIDENTAL CATCH CONCEPT IN TROLL FISHERY

Sam Wright

The term "shaker" is commonly applied to Pacific salmon (Oncorhynchus) taken in marine waters by commercial troll or sport hook-and-line gear but released due to closed seasons, minimum size limits, and market conditions. The problem stems from varying rates of mortality suffered by released salmon due to physical injury and the physiological trauma of being hooked. Without this loss, a significant percentage of these fish would become available to salmon fisheries when seasons opened, when they reached legal size, or when they migrated to areas and fisheries of differential regulations. Sublethal effects, such as slower growth and poorer condition, are also manifested.



Silver (or Coho) Salmon (Oncorhynchus kisutch)

Concern about the problem and sporadic studies date back to early stages of marine hook-and-line fisheries along the Pacific coast. Large-scale coordination by coastal salmon-management agencies began early in 1968 with emphasis on small chinook (O. tshawytscha) and coho (O. kisutch) in commercial troll fisheries. Canada and California led with initiation of logbook programs and gear-selectivity studies. These were due mainly to the impetus generated by recognition of serious problems with coho off the west coast of Vancouver Island and northern California.

Size of Problem

The magnitude of the problem was discussed in August 1968 at a Pacific Marine Fisheries Commission "Troll Salmon Workshop". Even with preliminary and admittedly incomplete data, the participants still agreed that the Pacific coast shaker salmon catch prior to June 15 might exceed 1,000,000 fish; up to 400,000 of these could be killed. Continuing research programs for British Columbia and California were bolstered by initiation of logbook programs and onboard observations in Oregon and Washington during 1970.

At 1970 meeting of Pacific Marine Fisheries Commission, past and present knowledge was presented in three parts: magnitude of catches, gear selectivity, and hooking mortality. A background paper documenting major regulatory statutes was presented at the 1969 Pacific Marine Fisheries Commission meeting.

These basic data convinced the Washington Department of Fisheries that sufficient evidence was available for immediate positive action on the coho shaker problem, at least on a trial basis. It sponsored "Trial Regulation of the Troll Fishery to Reduce the Catch of Coho Shakers", Resolution No. 17, adopted at the 1970 Commission meeting.

INCIDENTAL COHO CATCH PROPOSAL

Although the general ocean troll salmon season begins April 15, it is illegal to retain coho hooked until June 15 on all fishing grounds north of California. The management rationale is simply to protect a population in its final year of life--while a tremendous growth potential still exists. For California,

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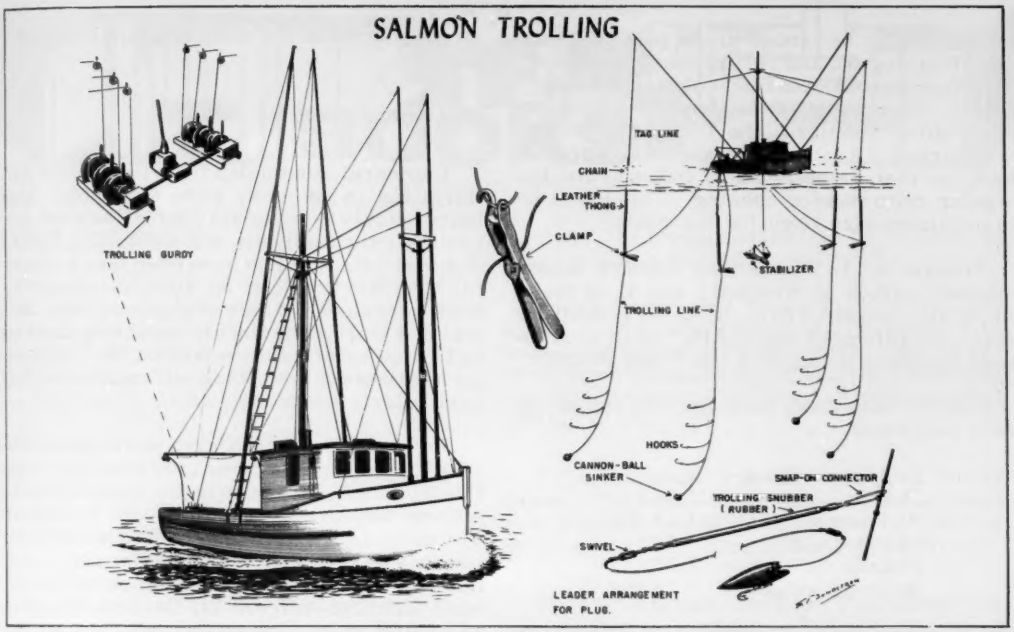

a 25-inch total length minimum is enforced for coho throughout the troll season; however, this falls at varying points in population's normal size distribution curve, depending on time of year and variations in growth rates. Differential protection to smaller fish of the same age-maturity class is the illogical result.

One key recommendation of PMFC Resolution No. 17 was a pre-June 15 incidental catch allowance for coho salmon poundage. This concept was based on the hypothesis that a coho's chances for survival could be determined reasonably well by visual observation as trolling gear brings them in. For example, recovery rates for three "condition categories" of live coho tagged during 1968 in outer Juan de Fuca Strait were:

Condition category	Number tagged	Number recovered	Percent recovered
"Good"	332	95	28.6
"Fair"	208	41	19.7
"Poor"	84	10	11.9

In the same study, 40 coho, or 6% of total catch, were completely expired when brought onboard. The intent, then, was to allow retention, and later sale, of coho brought onboard dead or badly injured--but to create no additional fishing effort (in terms of terminal gear, speed, depth, and/or area changes) specifically for this species.

TEST FISHERY

The incidental-catch concept received mixed blessings in nonsalmonid fisheries. It generated considerable speculation among Pacific coast management agencies. So a special test fishery was planned from June 1 to 5, 1971, off Grays Harbor. This is the center of Washington's spring-season trolling effort for chinook salmon.

Following a public information program, special permits were issued to 70 licensed troll vessels 16 to 50 feet long. These included members from tripboat, dayboat, kelper, and com-sport components and were representative of the total Grays Harbor fleet. The special permits stated: ". . . to retain coho salmon which are brought onboard dead or in a badly injured condition during his normal fishing effort for chinook salmon in the period June 1 through 5, 1971. Total poundage of these coho in a dressed condition shall not, however, exceed ten percent of the legal dressed chinook salmon poundage in possession of the fisherman. Further, all such coho

retained must be landed at the port of Westport, Washington, and relinquished to authorized Washington Department of Fisheries personnel. In compensation for the additional work effort required, the fisherman will be reimbursed at a rate per dressed weight pound equal to that established by industry for the regular coho season opening. There will be no minimum size limit for the coho."

From June 1 to 5, 51 permit holders landed chinook salmon at Westport, and 41 of these (80%) also landed coho. Weather conditions were exceptionally favorable. Both species were abundant throughout the 5-day period.

For 93 individual landings, the following were recorded:

Number chinook	- 2,313
Pounds chinook	- 25,855
Average weight	- 11.18 lbs.
Number coho	- 541
Pounds coho	- 2,268
Average weight	- 4.19 lbs.

Coho appeared in 67 landings, 8.8% of chinook catch on basis of weight, and 23.4% on basis of numbers. Ice boats, in 16 deliveries, accounted for 72.8% of chinook poundage, and 69.1% of coho poundage; day fishermen contributed the remainder in 77 individual landings. A few fishermen exceeded the 10% limit on coho deliberately or accidentally because they misunderstood terms of special permit. Subtracting these from total indicates that overall coho poundage level of 6% of chinook poundage would be realistic for predicting outcome of such a fishery on a regular basis.

In spite of a period for continued growth, a sample of troll coho taken off Grays Harbor after the regular season opening on June 15 averaged only 3.80 lbs. dressed. It appeared that terminal gear fished for chinook during the test fishery was more selective toward larger individuals of the available coho population.

Fisherman Reaction

In general, comments from fishermen participating in the study were favorable. Most learn quickly to estimate coho allowance percentage reasonably accurately during fishing. The test fishery might have been less successful if either chinook or coho abundance had been considerably less than prevailed. Most trollers were consciously selecting dead and badly injured coho for retention, but little objective data could be obtained from landed fish, particularly when dressed.

Unfavorable results from previous studies plus the troller's natural aversion to wastage ("belly burning" of coho in the round) prevented any request for landing coho uncleaned. The adverse comments on incidental catch allowance were mainly fears that landing of coho before regular June 15 season opening might have adverse affects on fishermen's price negotiations with industry.

RECOMMENDATIONS

To alleviate one specific component of Pacific coastal shaker salmon problem (preseason coho wastage), it is recommended that regulations be changed to allow a 10% coho allowance prior to June 15 on 1-year trial basis. During this full-scale test, detailed evaluation should be conducted, particularly through onboard observations of fishing operations.

ACKNOWLEDGMENTS

The troll coho test fishery was financed by Project No. 1-55-R-1, Ocean Salmon Fisheries Sampling, Commercial Fisheries Research and Development Act (PL 88-309).

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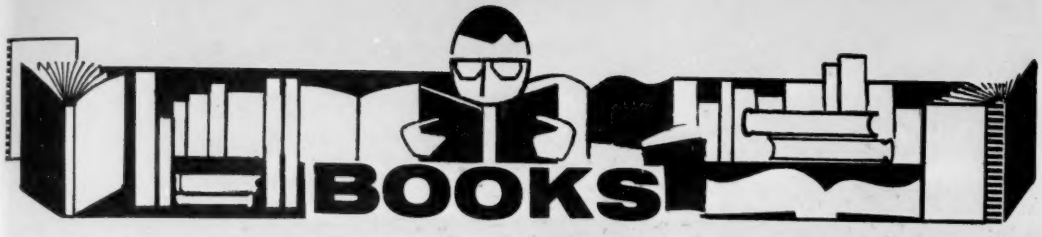


FISHERY BIOLOGY

"Fishery Bulletin" of the National Oceanic & Atmospheric Administration, National Marine Fisheries Service, Department of Commerce, Vol. 69, No. 2, April 1971, pp. 253-453, illus., contains 19 technical reports on investigations in fishery science.

Bulletins are distributed free to libraries, research institutions, State agencies, and scientists. Some bulletins are sold by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

"Swimming Speed, Tail Beat Amplitude, and Size in Jack Mackerel, Trachurus symmetricus, and Other Fishes," by John R. Hunter and James R. Zweifel, pp. 253-266.

"The objective of the study was to determine the relationships between swimming speed, fish length, tail beat amplitude, and tail beat frequency in a pelagic marine fish, jack mackerel, Trachurus symmetricus. To accomplish this objective, dorsal cine photographs were taken of fish swimming in currents of different speeds in a specially designed activity chamber. For comparative purposes tests were also run on three other marine fish: chub mackerel, Scomber japonicus; Pacific sardine, Sardinops sagax; and a shark, Triakis henlei."

"Sustained Speed of Jack Mackerel, Trachurus symmetricus," by John R. Hunter, pp. 267-272.

The purpose of this study was "to determine the sustained speed threshold of jack mackerel, Trachurus symmetricus, a pelagic marine fish of commercial importance. The body form and musculature of Trachurus appear to be designed for greater hydrodynamic efficiency at high speeds than other species heretofore studied. In Trachurus, lateral musculature is concentrated in the anterior portion of the trunk, and inserts by tendons on a small deeply forked caudal fin."

There is interest in comparing the sustained speed capabilities of Trachurus with that of fish with other body forms. Also, sustained speed data are significant in predicting migratory capabilities and physiological limits.

"The Transplanting and Survival of Turtle Grass, Thalassia testudinum, in Boca Ciega Bay, Florida," by John A. Kelly Jr., Charles M. Fuss Jr., and John R. Hall, pp. 273-280.

This article describes the procedures for and results of transplantation of turtle grass into modified environments. "Turtle grass was transplanted to an unvegetated, dredged canal and a hand-cleared portion of a flourishing grass bed. Complete or partial success was attained in 7 of 14 methods used. The best method, in which short-shoots (rhizomes removed) were dipped in a solution of plant hormone (Naphthalene Acetic Acid) and attached to construction rods for transplanting, was 100% successful and may be suitable for general application."

"Effect of Dietary Fish Oil on the Fatty Acid Composition and Palatability of Pig Tissues," by Robert R. Kifer, Preston Smith Jr., and Edgar P. Young, pp. 281-302.

This report deals with the problem of a "fishy" flavor in the meat of pigs. This flavor results sometimes when pigs are fed fishery products--fish meal, for example, above a certain concentration in the diet.

Pigs were fed diets containing fish oil to investigate: (1) the effect on the taste of meat of feeding fish oil to pigs, (2) the effect, on taste of meat, of withdrawing the oil from the

diet at given times, (3) the fatty acid composition of the body tissues of the pigs, and (4) the relation of composition to meat taste.

"Cetaceans from the Lesser Antillean Island of St. Vincent," by David K. Caldwell, Melba C. Caldwell, Warren F. Rathjen, and John R. Sullivan, pp. 303-312.

The authors present a preliminary list of cetaceans collected and observed in a fishery for blackfish or pilot whales (Globicephala) in waters of Lesser Antillean Island of St. Vincent. Nearest published records in the western Atlantic are given; also, limited biological notes on some species. The taxonomic relationships of the two forms of Stenella are suggested; both species are illustrated. Landings of pilot whales in the fishery over a 9-year period are included.

"Contributions to the Biology of the Royal Red Shrimp, Hymenopenaeus robustus Smith," by William W. Anderson and Milton J. Lindner, pp. 313-336.

The royal red shrimp, Hymenopenaeus robustus, has been located in commercial concentrations in three areas off the United States about 250 to 550 m deep: (1) the St. Augustine Grounds off Florida's east coast; (2) off Dry Tortugas; and (3) off Mississippi River Delta.

The authors collected information intermittently on the biology of the St. Augustine species.

The reproductive systems of males and females are described and illustrated. Burrowing and swimming habits observed from research submarine 'Aluminaut' are summarized.

"Sex Pheromone Activity of the Molting Hormone, Crustecdysone, on Male Crabs (Pachygrapsus crassipes, Cancer antennarius, and C. anthonyi)," by James S. Kittredge, Michelle Terry, and Francis T. Takahashi, pp. 337-344.

"The pheromone released by permolt female (Pachygrapsus crassipes) is a heat-stable non-ionic polar lipid. The coincidence of the release of the pheromone and the nubial molt suggested that the molting hormone, crustecdysone, may also function as a sex pheromone. Adult male crabs were observed to display typical precopulatory behavior when exposed to dilute solutions of crustecdysone." Threshold concentrations for behavioral response were found. These provide basis for a theory of the evolution of pheromone communication in the Arthropods.

"Characteristics of Sea-Surface Temperature Anomalies," by L.E. Eber, pp. 345-356.

"Sea-surface temperature anomalies in the North Pacific Ocean, constructed from a 14-year series (1949-62) of monthly mean charts, exhibit numerous instances of quasi-stationary behavior." Selected examples show a recurring pattern. The principal feature is a positive or negative cell in anomaly field between lat. 30° N and 50° N.

"Induced Spawning of the Northern Anchovy, Engraulis mordax Girard," by Roderick Leong, pp. 357-360.

"This report describes a method for bringing the anchovy to ripeness and the effectiveness of various hormone treatments in inducing spawning. As far as is known this was the first successful attempt to artificially mature and spawn this pelagic fish in the laboratory."

"Gill Raker Apparatus and Food Selectivity Among Mackerels, Tunas, and Dolphins," by John J. Magnuson and Jean G. Heitz, pp. 361-370.

This article describes quantitatively the gill raker apparatus of certain scombrids and coryphaenids with respect to the gap between gill rakers and filtering area of first gill arch, compares differences in gill raker gap among species and fish lengths; and considers proposition that observed inter- and intraspecific variations in the diet are associated functionally with morphometrics of gill raker apparatus.

"Nature of Free Radicals in Freeze-Dried Fishery Products and Other Lipid-Protein Systems," by William T. Roubal, pp. 371-377.

The article deals with recent research using systems which, for first time, are favorable for detection and study of electron

paramagnetic resonance (ERP) spectrometer signals that arise with onset of lipid oxidation. Mechanisms for forming radicals and reactions of radicals are discussed.

"The Relation Between Exercise and Biochemical Changes in Red and White Muscle and Liver in the Jack Mackerel, Trachurus symmetricus," by Austin W. Pritchard, John R. Hunter, and Reuben Lasker, pp. 379-386.

This study reexamined the "metabolic and locomotor roles of red and white muscle by measurement of glycogen, lactate, and fat levels in the muscle and glycogen levels in the liver in fish exposed to various velocity treatments of known strength and duration. Juvenile jack mackerel, Trachurus symmetricus, were used because the maximum sustained speed threshold for 6 hours of continuous swimming had been established for it--and all chemical measurements were related to known levels of swimming performance.

"Sebastes variegatus, Sp. N. from the Northeastern Pacific Ocean (Pisces Scorpaenidae)," by Jay C. Quast, pp. 387-398.

"A new scorpaenid fish, Sebastes variegatus, from the Gulf of Alaska is characterized by an elongate body that tapers symmetrically anteriorly and posteriorly; presence of preocular, postocular, tympannic, and parietal spines and lack of supraocular, coronal, and (usually) nuchal spines; 18 (rarely 17 or 19) rays in the pectoral fin; a second anal fin spine that is longer than the third; black membranes in the spinous dorsal and caudal fins; a dark brown to jet black peritoneum; and a dark blotched pattern on the sides that is interrupted over the posterior 2/3 of the body by an unpigmented band along the lateral line. The known geographic range is from Unimak Pass (Aleutian Islands) to Queen Charlotte Sound (British Columbia)."

"Calico Scallop Distribution, Abundance, and Yield Off Eastern Florida, 1967-68," by Richard B. Roe, Robert Cummins Jr., and Harvey R. Bullis Jr., pp. 399-410.

In an 18-month period, Aug. 1967-Dec. 1968, the NMFS Exploratory Fishing and Gear Research Base in Pascagoula, Miss., surveyed the calico scallop (Argopecten gibbus) grounds off eastern Florida. The survey disclosed aspects of life history, distribution, abundance, and yield and annual variation in geographical and depth distribution.

"Effects of Delayed Initial Feeding on Larvae of the Grunion, Leuresthes tenuis (Ayres)," by Robert C. May, pp. 411-426.

The purposes of this study were "to determine the effects of delayed initial feeding on mortality, on growth, and on the ability of grunion (Leuresthes tenuis) larvae to begin feeding and to utilize ingested food, and to ascertain what changes in the morphology and chemical composition of the larval body occur during starvation."

"The Relative Sampling Performance of 6- and 10-foot Isaacs-Kidd Midwater Trawls," by William A. Friedl, pp. 427-432.

This report deals with the relative sampling abilities of two sizes of Isaacs-Kidd midwater trawl (IKMT), a type of net used widely in marine and freshwater investigations. The results apply to IKMT in general; the assessment explains the degree to which data obtained with different trawls are comparable.

"Studies on the Use of Carbon Dioxide Dissolved in Refrigerated Brine for the Preservation of Whole Fish," by Harold J. Barnett, Richard W. Nelson, Patrick J. Hunter, Steven Bauer, and Herman Groninger, pp. 433-442.

Storing fish in refrigerated seawater has many advantages over storing them in ice, but the former also has disadvantages; one is the difficulty in controlling growth of spoilage bacteria in the fish. This article reports the effect on growth of bacteria in rockfish and chum salmon of dissolving carbon dioxide in brine. Storing fish in refrigerated brine treated with carbon dioxide inhibited bacteria growth, retarded rate at which fish decrease in quality, and increased their storage life by at least 1 week.

"DDT Residues in Seawater and Particulate Matter in the California Current System," by James L. Cox, pp. 443-450.

"Continuous samples of seawater and organic particulate material collected along

linear transects in the California current system were analyzed for DDT residues." DDT residue concentrations in whole seawater is determined. Geographical patterns in these concentration values are discussed in relation to mechanisms of land-sea DDT residue transfer. The author describes experimental results that implicate adsorption as the uptake mechanism for algal cells.

"Egg Loss During Incubation from Offshore Northern Lobsters (Decapoda: Homaridae)," by Herbert C. Perkins, pp. 451-453.

"Egg loss during incubation from offshore northern lobsters, Homarus americanus Milne Edwards, was estimated by counting the eggs of 196 females. The lobsters were captured along the continental shelf off southern New England during October (eggs recently extruded), April, and June (eggs nearly ready to hatch). Egg loss during the period October to June averaged 36% for females of all sizes studied."

THE FOLLOWING PUBLICATIONS OF THE DEPARTMENT OF COMMERCE, NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, NATIONAL MARINE FISHERIES SERVICE, ARE AVAILABLE FREE FROM DIVISION OF PUBLICATIONS, NOAA, CONNECTICUT AVE. & VAN NESS ST. NW., BLDG. 52, WASHINGTON, D.C. 20234:

DISCOLORATION IN CANNED CRAB MEAT

"Blueing of Processed Crab Meat. II. Identification of Some Factors Involved in the Blue Discoloration of Canned Crab Meat (Callinectes sapidus)," by Melvin E. Waters, SSR-Fisheries No. 633, 7 pp., illus., May 1971.

An outbreak of blue discoloration in canned crab meat occurred during 1969. Mr. Waters reports the result of a study to pinpoint the cause of blueing and suggest a remedy.

Results showed that iron was involved in the discoloration. Also, that a buffered solution of citric acid (pH 6.5-6.8) prevented formation of the blue-colored complex.

MECHANICAL PROCESSING OF BAY SCALLOP MEATS

"Influence of Mechanical Processing on the Quality and Yield of Bay Scallop Meats," by N. B. Webb and F. B. Thomas, SSR-Fisheries No. 624, 11 pp., illus., April 1971.

The commercial method of shucking bay scallops by hand is costly. A mechanical method has been developed to reduce costs while maintaining or improving quality of processed meats.

Shell stock loading conveyor for delivery to the rotating metal rollers.

This study compared quality and yield of bay scallops processed by mechanical means with corresponding values of those processed by typical hand method. The mechanical method included heat-shocking of the shellstock, roller-vibration removal of the meats and viscera, and later separation of viscera from meats.

The results indicate that quality and yield of meats from bay scallops processed mechanically "is equivalent to quality and yield of those processed commercially by hand."

FLOATING LABORATORY

"Floating Laboratory for Study of Aquatic Organisms and Their Environment," by George R. Snyder, Theodore H. Blahm, and Robert J. McConnell, Circular 356, 16 pp., illus., May 1971.

The National Marine Fisheries Service built a floating laboratory to study environmental problems in the Columbia River. The barge that supports the lab was provided by the U.S. Navy. A complex electrical and water-supply system, plus biological research equipment, were installed aboard barge. These made it possible to conduct research near sites where problems are expected to occur.

CALIFORNIA MARINE FISH CATCH

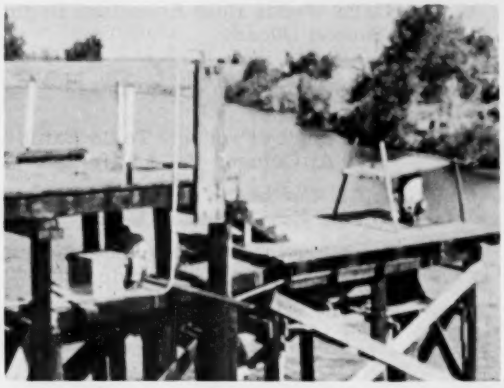
"The California Marine Fish Catch for 1969," by Leo Pinkas, Fish Bulletin 153, 47 pp., 2 figs., 24 tables, and an appendix, 1970. Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814.

This bulletin provides records of amounts and values of some living marine resources taken by California's commercial fisheries in 1969. It summarizes catches by partyboat sportfishing industry. The small quantities of freshwater fish taken commercially in inland areas are also detailed.

KING SALMON

"Migrations of Adult King Salmon (Oncorhynchus tshawytscha) in the San Joaquin Delta (As Demonstrated by the Use of Sonic Tags)," by Richard J. Hallock, Robert F. Elwell, and Donald H. Fry Jr., Fish Bulletin 151, 92 pp., 22 figs., 11 tables, 6 appendices, 1970. Department of Fish and Game, 1416 Ninth Street, Sacramento, California 95814.

Each fall king salmon pass through the Sacramento-San Joaquin Delta bound for the Sacramento and San Joaquin River systems. Starting in 1961, salmon runs of the San Joaquin, but not Sacramento's, suffered disaster.



Monitor housed on an irrigation pump platform, San Joaquin River near Bowman Road, fall 1965. (Photo: John A. Shaver)

This was due probably to water conditions in San Joaquin part of Delta. From 1964 through 1967, salmon tagged with sonic tags were released in Delta's central part to determine their reaction to low oxygen levels and reversed flows. Electronic equipment enabled researchers to follow tags and record their movement past fixed points. Salmon avoided water with less than 5 ppm dissolved oxygen by staying farther downstream until oxygen block cleared. Temperatures over 66° F. had a similar, but less sharply defined, effect.

INDEX

Page

UNITED STATES

1 . . Sec. Stans Reports Favorably On Sea Harvesting In Pribilof Islands

3 . . NMFS Studies Heavy-Metal Contamination of Fish

5 . . NMFS Protects More 'Continental Shelf Creatures'

5 . . U.S.-Soviet Fishery Survey Continues Off U.S. West Coast

6 . . NMFS Woods Hole Aquarium Begins Second Decade

6 . . NMFS Miami Lab Releases More Drift Bottles

6 . . U.S. Fishery Products To Be Exhibited At Cologne Food Fair

6 . . Gulf & Caribbean Fisheries Institute Meets Nov. 14-18 In Miami

7 . . Commerce Department Begins New Storm Information Service

8 . . Fishery Products Situation, by Donald R. Whitaker

Page

UNITED STATES (Contd.):

9 . . The U.S. Food Market - How Trends Affect Outlook For Canadian Groundfish Products

Oceanography:

18 . . International Study of Caribbean Currents In July And August

19 . . CLAMS: Resources Are Healthy, Says J. P. Wise

ARTICLES

21 . . Distribution of Some Coastal Pelagic Fishes In The Western Atlantic, by Edward F. Klima

35 . . The Atlantic Surf Clam Fishery - 1969, by Allan M. Barker and John W. Ropes

43 . . Trapping Sablefish, by William L. High

48 . . Coho Shaker Problem & Incidental Catch Concept In Troll Fishery, by Sam Wright

51 . . BOOKS

56 . . INDEX

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BACK COVER: Drying longline gear at Kewalo Basin, Honolulu. (H. Mann)